9th EPS-QEOD Europhoton Conference

EUROPHOTON

SOLID-STATE, FIBRE, AND WAVEGUIDE COHERENT LIGHT SOURCES

www.europhoton.org

CONFERENCE DIGEST

VIRTUAL CONFERENCE

30 August - 04 September 2020

Europhysics Conference Abstract Volume 44 A
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EUROPHOTON 2020 CONFERENCE DIGEST

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Digest and Copyright Information

The papers included in this digest comprise the short summaries of the **9th EPS-QEOD Europhoton Conference** virtually held from 30 August to 4 September 2020. The extended version of the papers (1-page summary in pdf format) will be made available on line within 2 months after the conference. A link with login and password is provided separately.

All web browsers (Firefox, Internet Explorer, Safari or similar) will allow you to download the digest.
A .pdf viewer (tested with Adobe Acrobat) will be necessary to view the papers. This software can be downloaded from **http://www.adobe.com**

The papers reflect the authors' opinion and are published as presented and without any change in the interest of timely dissemination. Their inclusion in these publications does not necessarily constitute endorsement by the editors, the European Physical Society.

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Introduction

***W**elcome to the **9th EPS-QEOD Europhoton Conference**!*

Established since 2004, this unique conference features the latest breakthroughs in the fields of **solid-state**, **fibre and waveguide light sources**.

World-renowned researchers will discuss the latest developments in the scientific community accompanied by **Summer School sessions** at the PhD student and postdoctoral level, and by informal breakout sessions for discussion. The conference will also feature a **half-day special Symposium on "Lasers for Space".**

This year the significant impact of COVID19 has placed impossible constraints on our community's ability to join in our planned location of Prague from 30 August to 4 September 2020. The organising committee finally decided to hold Europhoton 2020 as an online conference on the original dates.

Short abstracts of the papers to be presented at the EPS-QEOD Europhoton conference 2020 appear in this programme. 150 presentations (6 Summer School lectures, 2 keynotes, 10 invited speakers, 90 orals, 3 industrial talks, and 39 poster presentations from Europe and overseas) have been selected for presentation at the conference.

The ninth in a row, the Europhoton conference series has shown to be very popular among the scientists and engineers who have continued to place it on their calendars.

The conference is organised by the **European Physical Society** in cooperation with the **Quantum Electronics and Optics Division** (QEOD) of EPS, the **Czech Technical University in Prague (CTU)** and **DESY, Hamburg**.

Conference Topics

Solid State Lasers (SSL)
Novel laser material concepts. Growth, characterisation, and spectroscopic investigations of solid-state laser materials. Rare-earth-ion and transition-metal-ion lasers. Upconversion, tunable, and ultrafast solid-state lasers. Second and higher harmonic generation and optical parametric conversion of solid-state lasers. Modelling of solid-state lasers and resonators. Demonstration of novel pump sources and resonator geometries. Thermal and thermo-optical effects in solid-state lasers. High-power, diode-pumped, and ultra-stable systems. Non-linear materials. Non-linear optical sources. Metrology applications. Optically-pumped semiconductor lasers. Mid-infrared sources and materials

Fibre and Waveguide Devices (FWD)
Novel fibre and waveguide concepts. Fibre materials, fabrication, and characterisation. CW and pulsed fibre lasers. Bragg-grating fibre lasers. Amplification in doped fibres. Waveguide fabrication and characterisation. Waveguide lasers and amplifiers. Rare-earth doped amplifiers. Raman amplifiers. High-power fibre and waveguide lasers. Power-scaling concepts for fibre and waveguide lasers. Ultrafast fibre and waveguide sources. Photonic crystal and fibre light sources. Waveguided broadband and super-continuum light sources. Non-linear materials. Non-linear optical sources. Microcavity lasers.

Half-day special symposium "Lasers for Space"
Space is providing some of the greatest opportunities and challenges in Photonics, particularly in the areas of optical communications, laser telemetry and sensing. Optical communications in space strive for higher bandwidth and security, with applications from low-orbit satellite data transfer to the coverage of deep-space missions. Laser telemetry tackles practical and critical issues such as satellite and space debris monitoring, orbiting around the earth as well as around the moon and beyond, as well as testing fundamental physics. Higher-power lasers are also invited with various long-term prospects, such as space debris reduction and lightweight spacecraft acceleration, implying different major challenges according to whether they are operated from earth or within space.

Industrial Talks

An industrial session to take place on **Thursday 3 September 2020 from 19:30 to 20:15** will feature three talks:

Th-IND.1 19:30 **"Overview of company EKSPLA and products offered"** presented by **Giedrius Kudaba**, *EKSPLA, Vilnius, Lithuania*

Th-IND.2 19:45 **"Recent advancements in OPCPA front-end design and manufacturing"** presented by **Valdas Maslinkas**, *Light Conversion, Vilnius, Lithuania*

Th-IND.3 20:00 **"Overview on iXblue Photonics and focus on ModBox-FrontEnd Solution"** presented by **Hervé Gouraud**, *iXblue-Photonics, Besançon, France*

Presentation of the companies:

EKSPLA https://ekspla.com/

EKSPLA is manufacturer of solid-state lasers, laser systems and optoelectronics for basic research and industrial applications.
EKSPLA was established in the year 1992. Since then, EKSPLA had delivered a wide range of lasers and laser set-ups for science and industry. The company's products are successfully installed for many applications, some of them are specially tailored. One of the examples is the NL740 laser for LIDT application.

LIGHT CONVERSION http://lightcon.com/about-us.html

The key drivers at **LIGHT CONVERSION** are consistency, the persistent quest for corporate goals, close attention to clients' needs, and an assurance of the exclusive quality of the products developed by the company. We have been developing technologies that alter the worlds of science and industry. Using our knowledge, experience, and leading position, we strive for perfection and continued growth.

iXblue PHOTONICS https://photonics.ixblue.com/

iXblue photonics is a global high-tech company specializing in the design and manufacturing of advanced photonics technologies. We produce LiNbO3 modulators and their matching components, turn-key and ease to use modulation solutions, fibres, FBGs… Our solutions are dedicated to laser, from oscillator to high power, and from ground to space.

Summer Schools

Six summer school lectures will be held **from Sunday 30 August (afternoon) to Monday 31 August (all day), 2020**. PhD Students and Postdocs are especially invited to attend theses schools. The summer schools will give students a chance to get introduced into various laser related subjects, covering the basics up to the latest research results.

Lecturers who are internationally renowned in their research subjects will present the lecture programme. See programme on the respective pages of this programme

Poster Sessions and Instructions for Poster Presenters

Poster sessions for contributed papers have been a major attraction at recent conferences. Poster presentations provide a direct interaction between the presenter and the viewer.

Three e-poster sessions with 13 posters each are scheduled as follows:
Tu-P1: Tuesday 1 September 2020 from 15:30 to 17:00 CET time.
We-P2: Wednesday 2 September 2020 from 19:30 to 21:00 CET time.
Th-P3: Thursday 3 September 2020 from 08:30 to 10:00 CET time

These sessions will allow participants to speak with the poster authors. Prior speaking with them their 3-4 page presentation and their short video (if provided) can be viewed on the conference website.

In order to present their work and answer questions, authors are requested to be present in their e-poster session on the assigned day ten minutes prior the session begins.

The list of all posters is presented on the respective pages of this programme.

Speakers' Information

Summer schools will be featured as a virtual Zoom meeting. All other oral sessions will be featured as a webinar Zoom meeting where all contributors will receive a time slot to respect within the session. All speakers are asked to check-in with the session presider in the virtual room ten minutes before the session begins. At the end of their talks, speakers will be asked to answer questions. The session chair will read the live questions according to the amount of time left within the time slot.

Keynote, invited and summer school presentations will be webcasted in live. Concerning oral presentations, pre-recordings will be used exclusively and webcasted.

Duration of the presentations:
Keynote: 38 minutes live presentation + 7 minutes live for discussion.
Invited: 25 minutes live presentation + 5 minutes live for discussion.
Oral: 12 minutes pre-recorded presentation + 3 minutes live for discussion
Summer school: 2x 45 minutes live streaming with ½ hour break in-between
Industrial talks: 10 minutes pre-recorded presentation + 3-5 minutes live for discussion).

Important:
Speakers are asked to check-in with the session presider in the conference room ten minutes before the session begins.
Summer schools and industrial talks have no session presider. Speakers of the schools or the industrial talks will directly conduct the Q&A.

Conference Language

English will be the official conference language.

Technical Digest

The online technical digest including the one-page summaries will be available within 2 months after the conference. The link to upload the material will be given via email to the registered participants.

Registration Information

Europhoton 2020 will be held all in virtual. Online registration is mandatory. Each participant (speaker, poster presenter or conference attendant) is requested to register online. The managing society will keep the right to accept/refuse participants in case online registration was not done. Registration is open to all members of the scientific and technical community.

Registration fees:
Summer school, keynote and invited speakers have their registration fees waived. The other contributors will have to pay a fee as detailed on the conference website. Non-presenting attendees have no fee to pay.

Conference Hours (CEST time zone)

	Morning		Afternoon	
Sunday 30 August 2020			14:00 – 18:15	(*)
Monday 31 August 2020	08:30 – 12:45	(*)	14:00 – 18:15	(*)
Tuesday 1 September 2020	08:30 – 12:30		13:30 – 19:00	
Wednesday 2 September 2020	08:30 – 12:00		13:30 – 21:00	
Thursday 3 September 2020	08:30 – 12:00		13:30 – 20:15	
Friday 4 September 2020	08:45 – 12:15		13:30 – 17:15	

(*) Summer School

Breaks

	Morning	Lunch time	Afternoon
Sunday 30 August 2020			16:00 – 16:15
Monday 31 August 2020	10:30 – 10:45	12:45 – 14:00	16:00 – 16:15
Tuesday 1 September 2020	10:30 – 10:45	12:30 – 13:30	15:15 – 15:30 17:00 – 17:15
Wednesday 2 September 2020	10:15 – 10:30	12:00 - 13:30	15:15 – 15:30 19:15 – 19:30
Thursday 3 September 2020	10:00 – 10:15	12:00 - 13:30	15:15 – 15:30 19:15 – 19:30
Friday 4 September 2020	10:15 – 10:30	12:15 - 13:30	15:15 – 15:30

Conference Committees

General Chair
Václav Kubeček, *Czech Technical University, Prague, Czech Republic*

Programme Chair
Philippe Grelu, *University Bourgogne-Franche-Comté, Dijon, France*

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Uwe Griebner, *Max Born Institute, Berlin, Germany*
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Conference Management

The European Physical Society provides the Conference Management, 6 rue des Frères Lumière, 68200 Mulhouse, France.

This programme is edited by P. Helfenstein and A.Wobst.

Sunday 30 August 2020 (Summer School)

SS1	**14:00 - 16:00**	**Summer School Lecture 1** **Rüdiger Paschotta**, *RP Photonics Consulting GmbH, Bad Dürrheim, Germany* **"Power scaling of lasers"**
	16:00 - 16:15	Break
SS2	**16:15 - 18:15**	**Summer School Lecture 2** **Pavel Peterka**, *Institute of Photonics and Electronics, The Czech Academy of Sciences, Prague, Czech Republic* **"Double-clad fibers for high-power fiber lasers"**

Monday 31 August 2020 (Summer School)

SS3	**08:30 - 10:30**	**Summer School Lecture 3** **Rich Mildren,** *Macquarie University, Sydney, Australia* **"Diamond optics and lasers"**
	10:30 - 10:45	Break
SS4	**10:45 - 12:45**	**Summer School Lecture 4** **Kyunghwan Oh**, *Yonsei University, Seoul, South Korea* **"Short pulse generation in fiber lasers"**
	12:45 - 14:00	Lunch Break
SS5	**14:00 - 16:00**	**Summer School Lecture 5** **Günter Steinmeyer**, *Max-Born Institute, Berlin, Germany* **"Ultrashort pulse characterization"**
	16:00 - 16:15	Break
SS6	**16:15 - 18:15**	**Summer School Lecture 6** **Majid Ebrahim-Zadeh**, *ICFO, Castelldefels (Barcelona), Spain* **"Progress in optical parametric oscillators"**

Tuesday 1 September 2020 (Main Conference)

1	**08:30 - 08:45**	**Chairs' welcome**
Tu-M1	**08:45 - 10:30**	**High harmonic generation and attosecond pulses** (oral session)
	10:30 - 10:45	Break
Tu-M2	**10:45 - 12:30**	**Ultrafast fiber lasers** (oral session)
	12:30 - 13:30	Lunch Break
Tu-A1	**13:30 - 15:15**	**Laser amplifiers and THz generation** (oral session)
	15:15 - 15:30	Break
Tu-P1	**15:30 - 17:00**	**Poster session 1**
	17:00 - 17:15	Break
Tu-A2	**17:15 - 19:00**	**Ultrafast fiber lasers and amplifiers** (oral session)

Wednesday 2 September 2020 (Main Conference)

We-Symp1		
	08:30 - 10:15	**Lasers for space: Ranging** (oral session)
	10:15 - 10:30	Break
We-Symp2		
	10:30 - 12:00	**Lasers for space: Communications** (oral session)
	12:00 - 13:30	Lunch Break
We-A1	**13:30 - 15:15**	**Few-cycle pulse generation and application** (oral session)
	15:15 - 15:30	Break
We-A2	**15:30 - 17:15**	**Fiber and waveguide resonators and characterization** (oral session)
	17:15 - 17:30	Break
We-A3	**17:30 - 19:15**	**Novel laser materials** (oral session)
We-P2	**19:30 - 21:00**	**Poster session 2**

Thursday 4 September 2020 (Main Conference)

Th-P3	**08:30 - 10:00**	**Poster session 3**
	10:00 - 10:15	Break
Th-M1	**10:15 - 12:00**	**Non-linear conversion in fibers and waveguides** (oral session)
	12:00 - 13:30	Lunch Break
Th-A1	**13:30 - 15:15**	**Mid infrared sources and characterization** (oral session)
	15:15 - 15:30	Break
Th-A2	**15:30 - 17:15**	**Solitons I, supercontinuum and Raman processes in fibers** (oral session)
	17:15 - 17:30	Break
Th-A3	**17:30 - 19:15**	**Optical Parametric Oscillators** (oral session)
	19:15 - 19:30	Break
Th-IND	**19:30 - 20:15**	**Industrial session** (oral session)

Friday 4 September 2020 (Main Conference)

Fr-M1	**08:45 - 10:15**	**Solitons II, fiber fabrication and design** (oral session)
	10:15 - 10:30	Break
Fr-M2	**10:30 - 12:15**	**Pulse compression** (oral session)
	12:15 - 13:30	Lunch Break
Fr-A1	**13:30– 15:15**	**Fiber lasers: transverse mode stability and special wavelengths** (oral session)
	15:15 - 15:30	Break
Fr-A2	**15:30 - 17:00**	**Oscillators and combs** (oral session)
2	**17:00 - 17:15**	**Closing remarks**

Summer School Programme

Six Summer Schools will take place **from Sunday 30 August (afternoon) to Monday 31 August (all day), 2020.** The Summer School Lecturer will arrange for **2x 45 minutes lecture and ½ hour break in-between.**

Sunday 30 August, 14:00 – 16:00
SS1: "Power Scaling of Lasers"
Rüdiger Paschotta, *RP Photonics Consulting GmbH, Bad Dürrheim, Germany*
The concept of "power scaling" and "scalability" of laser architectures can provide important insight for the evaluation of the future performance potential of different laser architectures, and for identifying long-lasting solutions as well as technological bottlenecks. For this purpose, the general concept of scaling must be applied to laser technology in a meaningful way. The talk presents a way to do this and demonstrates that it helps to analyze various issues in the context of high power lasers.

Sunday 30 August, 16:15 – 18:15
SS2:* "*Double-clad fibers for high-power fiber lasers"
Pavel Peterka, *Institute of Photonics and Electronics, The Czech Academy of Sciences, Prague, Czech Republic*
The invention of cladding pumping within a double-clad active fiber structure enabled high-power operation of fiber lasers. This tutorial will review principles of efficient pump absorption in double-clad fibers, fiber fabrication and characterization, pump and signal combiners, large mode area fibers, as well as practical limitations and emerging technologies.

Monday 31 August, 08:30 – 10:30
SS3 "Diamond optics and lasers"
Rich Mildren, *Macquarie University, Sydney, Australia*
Diamond's extreme properties are well known in many contexts, however, its use in optics is only fairly recent with high-quality growth only available in the last decade. This tutorial aims to review its optical properties and to show how a key subset of these is leading to lasers with outstanding performance characteristics.

Monday 31 August, 10:45 – 12:45
SS4: "Short pulse generation in fiber lasers"
Kyunghwan Oh, *Yonsei University, Seoul, South Korea*
2-D materials have been successfully employed as an all-fiber saturable absorber. We review mode-locking and Q-switching schemes in fiber lasers based upon novel saturable absorbers.
OCIS codes: (060.2320) Fiber optics amplifiers and oscillators; (140.3510) Lasers, fiber; (160.4236) Nanomaterials

Monday 31 August, 14:00 – 16:00
SS5: "Ultrashort pulse characterization"
Günter Steinmeyer, *Max-Born Institute, Berlin, Germany*
Methods for measurement and characterization of femtosecond laser pulses are reviewed, starting with simple autocorrelation measurements, expanding on second-generation methods like FROG, SPIDER and d-scan, which allow reconstruction of phase and amplitude. Finally, third-generation methods are discussed, which additionally enable reconstruction of coherence properties of unstable pulse trains.

Monday 31 August, 16:15 – 18:15
SS6: "Progress in optical parametric oscillators"
Majid Ebrahim-Zadeh, *ICFO, Castelldefels (Barcelona), Spain*
This lecture will provide an overview of optical parametric oscillators (OPOs), from basic operating principles to advanced devices. The course will include a description of fundamental concepts in parametric generation, followed by discussion of different system architectures, an overview of the latest advances in the field, and applications of OPO technology

Tuesday 1 September 2020

Tu-M1: High harmonic generation and attosecond pulses, 8:45 - 10:30

8:45 - 9:15 Invited

High-harmonic generation in the water window with a high-average power mid-infrared OPCPA at 100 kHz

Pierre-Alexis Chevreuil, *Department of Physics, Institute for Quantum Electronics, ETH Zürich, Switzerland*

We present an OPCPA with 25 W average power, generating 16.5 fs pulses with 14 GW peak power at 2.2 m with 100 kHz repetition rate. This source enabled high-harmonic generation spanning the fullwater-window 284-543 eV, and extending up to 620 eV.

10:00 - 10:30 Invited

ELI ALPS – The next generation of attosecond sources

Katalin Varjù, *ELI-HU Laser Institute, Szeged, Hungary*

The Extreme Light Infrastructure Attosecond Light Pulse Source ELI-ALPS, the Hungarian pillar of ELI, is the first of its kind that operates by the principle of a user facility, supporting laser based fundamental and applied researches in physical, biological, chemical, medical and materials sciences at extreme short time scales.

Tu-M2: Ultrafast fiber lasers, 10:45 - 12:30

10:45 - 11:15 Invited

Flexible all-PM NALM Yb:fiber laser design for low-noise frequency comb applications and single-cavity dual-comb generation

Oliver Heckl, *University of Vienna, Vienna, Austria*

We present a versatile all-PM Ybfiber-laser and demonstrate the impact of dispersion engineering on amplitudephase noise and the carrier-envelope-offset frequency, showing single-digit-kHz values in free-running operation. We then demonstrate dual-comb generation from a single fiber laser via spectral subdivision producing a non-aliasing bandwidth of 2.5 THz.

Tu-A2: Ultrafast fiber lasers and amplifiers, 17:15 - 19:00

17:15 - 17:45 Invited

Ultra-low-noise ultrafast fiber lasers

Alexander M. Heidt, *Institute of Applied Physics, University of Bern, Bern, Switzerland*

The seeding of ultrafast fiber amplifiers with coherent all-normal dispersion fiber supercontinuum pulses is shown to be a convenient route to extend the ultra-low noise properties of mature Erbium-fiber technology to other wavebands. An order of magnitude reduction of relative intensity noise is achieved for ultrafast systems at 2 m.

Wednesday 2 September 2020

We-Symp1: Lasers for space: Ranging, 8:30 - 10:15

8:30 - 09:15 Keynote

Lasers and optics for the Laser Interferometer Space Antenna (LISA)

Nelson Christensen, *Artemis, Observatoire de la Côte d'Azur, Université Côte d'Azur, Nice, France*

LISA will be a large-scale space mission to detect gravitational waves. LISA will observe the entire universe directly with gravitational waves. This talk will summarize the LISA Mission, with an emphasis on the complex laser, optical and interferometric systems that must operate over a baseline of 2.5 million km.

9:45 - 10:15 Invited

Laser ranging to satellites and space debris

Georg Kirchner, *Austrian Academy of Science, Space Research Institute, Graz, Austria*

More than 40 Satellite Laser Ranging SLR stations around the world measure distances to retro-reflector-equipped satellites up to the geostationary orbit, determining their orbits with an accuracy of up to few millimetres. In addition, this technique now is also used to range to space debris targets.

We-Symp2: Lasers for space: Communications, 10:30 - 12:00

10:30 - 11:00 Invited
New photonics for improved Space Quantum Communications
Paolo Villoresi, *Dipartimento di Ingegneria dell'Informazione, Università di Padova, Italy*
The daylight QKD for space links leveraging latest photonics technology is described, with the reduction of the qubit preparation errors, aiming at the most pure transmitter for high efficiency key rate. Integrated photonics platform was also demonstrated as suitable for daylight QKD, with a remarkable increase in efficiency and compactness.

11:30 - 12:00 Invited
Laser-based time transfer through free-space links
Ivan Prochazka, *Czech Technical University in Prague, Czech Republic*
We are reporting on a new approach to an optical two-way free space time transfer which is based on signals of individual photons. This approach enables to reach timing stabilities on a sub-ps level and systematic errors as low as units of ps using existing electro-optic technologies.

We-A1: Few-cycle pulse generation and application, 13:30 - 15:15

13:30 - 14:15 Keynote
ATTOSECOND METROLOGY 2.0, from tracking electronic motions to detecting cancer
Ferenc Krausz, *Max Planck Institute of Quantum Optics, Garching and Ludwig-Maximilians-Universität München, Munich, Germany*
Sub-femtosecond current injection into wide-gap materials can directly probe ultrafast electron phenomena in condensed matter systems and also be used for sampling the electric field of light. This opens the door for real-world applications, such as early cancer detection by measuring miniscule changes of the molecular composition of blood via field-resolved vibrational molecular fingerprinting.

Thursday 3 September 2020

Th-A1: Mid infrared sources and characterization, 13:30 - 15:15

13:30 - 14:00 Invited
Mid-infrared electric field sampling approaching single-photon sensitivity
Christina Hofer, *Max Planck Institute of Quantum Optics, Garching, Germany*
We present a Thulium-fiber-laser-based, field-resolved spectrometer, optimized for mid-infrared photon detection efficiency. With this system, we measure few-cycle mid-infrared fields with nearly single-photon sensitivity via electro-optic sampling. This pushes field-resolved spectroscopy to its fundamental limits and paves the way for linear detection of mid-infrared intensities over 18 orders of magnitude.

Th-A2: Solitons I, supercontinuum and Raman processes in fibers, 15:30 - 17:15

15:30 - 16:00 Invited
Time-locked multi-color single-aperture fiber sources via soliton self-mode conversion
Havva Begüm Kabagöz, *Boston University, Boston, USA*
Group-velocity matching across spatial modes of multimode fibers yields dual-, triple-, or even quadruple-color energetic ultrashort pulses that are naturally temporally locked and emit from a single fiber aperture. The underlying mechanism is the recently discovered soliton self-mode conversion process that governs soliton dynamics in multimode fibers.

Friday 4 September 2020

Fr-M1: Solitons II, fiber fabrication and design, 08:45 - 10:15

08:45 - 09:15 Invited

Polychromatic soliton molecules from a fiber laser

Joshua P. Lourdesamy, *Institute of Photonics and Optical Science (IPOS), School of Physics, The University of Sydney, Australia*

We experimentally confirm the existence of soliton molecules formed by a bound state of two fundamental solitons centered at different frequencies, but with identical group velocities, inside a mode-locked laser with a spectral pulse-shaper to achieve the desired dispersion. The frequency difference leads to temporal beating and to pulse narrowing.

SS1: Summer school lecture: Power scaling of lasers

Time: Sunday, 14:00–16:00 Location: virtual

Summer school SS1.1 14:00

Power Scaling of Lasers — •Rüdiger Paschotta — RP Photonics Consulting GmbH, Bad Dürrheim, Germany

The concept of power scalability of laser architectures provides important insight for the evaluation of the future performance potentials and for identifying long-lasting solutions as well as technological bottlenecks. For this purpose, the general concept of scaling must be applied to laser technology in a meaningful way.

SS2: Summer school lecture: Double-clad fibers for high-power fiber lasers

Time: Sunday, 16:15–18:15 Location: virtual

Summer school SS2.1 16:15

Double-clad fibers for high-power fiber lasers — •Pavel Peterka — Institute of Photonics and Electronics, The Czech Academy of Sciences, Chaberska 57, 182 51 Prague, Czechia

The invention of cladding pumping within a double-clad active fiber structure enabled high-power operation of fiber lasers. This tutorial will review principles of efficient pump absorption in double-clad fibers, fiber fabrication and characterization, pump and signal combiners, large mode area fibers, as well as practical limitations and emerging technologies.

SS3: Summer school lecture: Diamond optics and lasers

Time: Monday, 8:30–10:30 Location: virtual

Summer school SS3.1 8:30
Diamond optics and lasers — •Rich Mildren — Macquarie University, Sydney, Australia

Diamond's extreme properties are well known in many contexts, however, its use in optics is only fairly recent with high-quality growth only available in the last decade. This tutorial aims to review its optical properties and to show how a key subset of these is leading to lasers with outstanding performance characteristics.

SS4: Summer school lecture: Short pulse generation in fiber lasers

Time: Monday, 10:45–12:45 Location: virtual

Summer school SS4.1 10:45
Short pulse generation in fiber lasers — •Kyunghwan Oh — Department of Physics, Yonsei University, 50 Yonsei-ro Seodaemun-gu, Seoul, Korea

2-D materials have been successfully employed as an all-fiber saturable absorber. We review mode-locking and Q-switching schemes in fiber lasers based upon novel saturable absorbers. OCIS codes: (060.2320) Fiber optics amplifiers and oscillators; (140.3510) Lasers, fiber; (160.4236) Nanomaterials

SS5: Summer school lecture: Ultrashort pulse characterization

Time: Monday, 14:00–16:00 Location: virtual

Summer school SS5.1 14:00
Ultrashort pulse characterization — •Günter Steinmeyer — Max Born Institute, Berlin, Germany

Methods for measurement and characterization of femtosecond laser pulses are reviewed, starting with simple autocorrelation measurements, expanding on second-generation methods like FROG, SPIDER and d-scan, which allow reconstruction of phase and amplitude. Finally, third-generation methods are discussed, which additionally enable reconstruction of coherence properties of unstable pulse trains.

SS6: Summer school lecture: Progress in optical parametric oscillators

Time: Monday, 16:15–18:15 Location: virtual

Summer school SS6.1 16:15
Progress in optical parametric oscillators — •Majid Ebrahim-Zadeh — ICFO, Castelldefels, Spain

The course will include a description of fundamental concepts in parametric generation, followed by discussion of different system architectures, an overview of the latest advances in the field, and applications of OPO technology

8:30–8:45: Chairs welcome

Tu-M1: High harmonic generation and attosecond pulses

Chaired by Lazlo Veisz, Umea University, Sweden

Time: Tuesday, 8:45–10:30 Location: virtual

Invited Tu-M1.1 8:45

High-harmonic generation in the water window with a high-average power mid-infrared OPCPA at 100 kHz — •Pierre-Alexis Chevreuil, Justinas Pupeikis, Nicolas Bigler, Lukas Gallmann, Christopher Richard Phillips, and Ursula Keller — Department of Physics, Institute for Quantum Electronics, ETH Zurich, Switzerland

We present an OPCPA with 25 W average power, generating 16.5 fs pulses with 14 GW peak power at 2.2 μm with 100 kHz repetition rate. This source enabled high-harmonic generation spanning the full water-window (284-543 eV), and extending up to 620 eV.

Oral Tu-M1.2 9:15

Femtosecond soft–X–Ray absorption spectroscopy of liquids with a water-window high-harmonic source — •Tadas Balciunas[1], Adam Smith[2], Yi-Ping Chang[1], Cédric Schmidt[1], Kristina Zinchenko[2], Fernanda Nunes[2], Vit Svoboda[2], Emanuele Rossi[2], Zhong Yin[2], Jean-Pierre Wolf[1], and Hans-Jakob Wörner[2] — [1]GAP-Biophotonics, Université de Genéve, 1205 Geneva, Switzerland — [2]Laboratory for Physical Chemistry, ETH Zürich, 8093 Zürich, Switzerland

We demonstrate femtosecond time–resolved soft–X–ray absorption spectroscopy of liquid samples by combining a sub–micrometer–thin flat liquid jet with a high–harmonic table–top source covering the entire water-window range. Our work represents the first extension of table-top XAS to the oxygen edge of a chemical sample in the liquid phase.

Oral Tu-M1.3 9:30

High-harmonic generation inside a 100-fs Yb:YAG Kerr-lens mode-locked thin-disk laser oscillator — •Jakub Drs, Julian Fisher, François Labaye, Norbert Modsching, Valentin J. Wittwer, and Thomas Südmeyer — Laboratoire Temps-Fréquence, Institut de Physique, Université de Neuchâtel, Neuchâtel, Switzerland

We report on high-harmonic generation inside a Kerr-lens mode-locked thin-disk laser oscillator based on Yb:YAG gain material. The system operates at 400-MW intracavity peak power with 100-fs pulses at 11 MHz. The total XUV generated flux in argon is ~2 μW with photon energies up to 37 eV.

Oral Tu-M1.4 9:45

Femtosecond arrival time stability of pump probe laser system at the FLASH free electron laser — •Nora Schirmel, Sebastian Schulz, Bastian Manschwetus, Jost Müller, Holger Schlarb, and Ingmar Hartl — Deutsches Elektronen-Synchrotron, Hamburg, Germany

The arrival time of the burst-mode OPCPA laser system for XUV–NIR pump-probe experiments at the XUV free-electron laser FLASH was characterized. After 40 m beamtransport to the experimental endstation we measured a fluctuation of 7.8 fs rms and 134 fs p-p in a 5 min and 24 hour period, respectively.

Invited Tu-M1.5 10:00

ELI ALPS – The next generation of attosecond sources — •Katalin Varjù — ELI-HU Laser Institute, Szeged, Hungary

The Extreme Light Infrastructure – Attosecond Light Pulse Source (ELI-ALPS), the Hungarian pillar of ELI, is the first of its kind that operates by the principle of a user facility, supporting laser based fundamental and applied researches in physical, biological, chemical, medical and materials sciences at extreme short time scales.

Tuesday

Tu-M2: Ultrafast fiber lasers

Chaired by Cesare Jauregui, Institute of Applied Physics, Jena University, Jena, Germany

Time: Tuesday, 10:45–12:30 Location: virtual

Invited Tu-M2.1 10:45

Flexible all-PM NALM Yb:fiber laser design for low-noise frequency comb applications and single-cavity dual-comb generation — •Oliver Heckl — University of Vienna, Vienna, Austria

We present a versatile all-PM Yb:fiber-laser and demonstrate the impact of dispersion engineering on amplitude/phase noise and the carrier-envelope-offset frequency, showing single-digit-kHz values in free-running operation. We then demonstrate dual-comb generation from a single fiber laser via spectral subdivision producing a non-aliasing bandwidth of ~2.5 THz.

Oral Tu-M2.2 11:15

Amplitude-noise reducing mechanism in fiber lasers mode-locked with nonlinear amplifying loop mirror — •Marvin Edelmann[1,2,3], Yi Hua[1,4], Kemal Şafak[3], and Franz Kärtner[1,4] — [1]Center for Free-Electron Laser Science (CFEL), DESY, Hamburg, Germany — [2]Universität Oldenburg, Oldenburg, Germany — [3]Cycle GmbH, Hamburg, Germany — [4]Universität Hamburg, Hamburg, Germany

In this work, an amplitude-noise reducing mechanism in a fiber laser mode-locked with nonlinear amplifying loop mirror is investigated experimentally. By comparing the laser with an amplifier system that shows similar transmission behavior it becomes evident, that the transmission function of the laser can induce amplitude-noise reduction for certain steady-states.

Oral Tu-M2.3 11:30

A passively mode-locked Holmium fiber oscillator based on a Nonlinear Amplifying Loop Mirror operating at 2050 nm — •Christoph Mahnke[1], Yuxuan Ma[1], Sarper Salman[1,2], Christoph M. Heyl[1,2], and Ingmar Hartl[1] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]Helmholtz-Institute Jena, Jena, Germany

We demonstrate an environmentally stable, passively mode-locked Holmium fiber oscillator operating at 2050 nm. Using a Nonlinear Amplifying Loop Mirror, it is self -starting and generates pulses of 95 pJ energy at a repetition rate of 41.7 MHz. We intend to use it for seeding a Ho:YLF amplifier.

Oral Tu-M2.4 11:45

Broadband Mamyshev oscillator around 1550 nm in stable and multiple pulse regimes — •Coraline Lapre[1], Cyril Billet[1], Fanchao Meng[1], Christophe Finot[2], Lauri Salmela[3], Goery Genty[3], and John M. Dudley[1] — [1]Institut FEMTO-ST, Université Bourgogne Franche-Comté CNRS UMR 6174, Besançon, France — [2]Laboratoire Interdisciplinaire Carnot de Bourgogne, Université Bourgogne Franche-Comté CNRS UMR 6303, Dijon, France — [3]Photonics Laboratory, Tampere University, Tampere, FI-33104, Finland

New insights into stable and multipulse dynamics in an all polarization-maintaining fibre Mamyshev oscillator are obtained using frequency resolved optical gating and dispersive Fourier transform characterization. The source generates 100 nm bandwidth highly-chirped pulses around 1550 nm.

Oral Tu-M2.5 12:00

High-energy pulses from an Yb-doped fiber Mamyshev oscillator by the use of a few-mode amplification fiber — •Paul Repgen[1], Dieter Wandt[1], Andreas Wienke[1], Uwe Morgner[1,2,3], Jörg Neumann[1,2], and Dietmar Kracht[1,2] — [1]Laser Zentrum Hannover, Hannover, Germany — [2]Cluster of Excellence PhoenixD (Photonics, Optics, and Engineering Innovation Across Disciplines), Hannover, Germany — [3]Institut für Quantenoptik, Leibniz Universität Hannover, Hannover, Germany

We use a standard step-index few-mode Yb-doped gain fiber with a core diameter of 20μm in a Mamyshev oscillator to generate pulse energies of more than 500nJ directly from the laser oscillator. The pulses can be compressed to sub-100fs with an efficiency of 85%.

Oral Tu-M2.6 12:15

Generation of high-energy pulses in a Thulium-doped fiber Mamyshev oscillator — •Paul Repgen[1], Benedikt Schuhbauer[1], Moritz Hinkelmann[1,2], Dieter Wandt[1], Andreas Wienke[1], Uwe Morgner[1,2,3], Jörg Neumann[1,2], and Dietmar Kracht[1,2] — [1]Laser Zentrum Hannover, Hannover, Germany — [2]Cluster of Excellence PhoenixD (Photonics, Optics, and Engineering Innovation Across Disciplines), Hannover, Germany — [3]Institut für Quantenoptik, Leibniz Universität Hannover, Hannover, Germany

We present a Mamyshev oscillator based on anomalous dispersive Tm-fibers and with a fiber-based dispersion management, which emits pulses with energies of more than 6nJ at 16MHz repetition rate at 1960nm wavelength. The optical spectrum spans over 58nm and the pulses were compressed to 138fs assuming a Gaussian-shaped profile.

Tu-A1: Laser amplifiers and THz generation

Chaired by Chris Phillips, ETH, Zürich, Switzerland

Time: Tuesday, 13:30–15:15 Location: virtual

Oral Tu-A1.1 13:30

Programmable Generation of Multi-Millijoule Femtosecond Pulse Bursts with Terahertz Intraburst Repetition Rate — •Vinzenz Stummer[1], Tobias Flöry[1,2], Edgar Kaksis[1], Audrius Pugžlys[1,3], and Andrius Baltuška[1,3] — [1]Photonics Institute, TU Wien, Gusshausstrasse 27-387, A-1040 Vienna, Austria — [2]Institute of Theoretical Chemistry, University of Vienna, Währingerstraße 17, A-1090 Vienna, Austria — [3]Center for Physical Sciences & Technology, Savanoriu Ave. 231 LT-02300 Vilnius, Lithuania.

We demonstrate femtosecond pulse burst generation, based on direct time-domain methods and utilization of the Vernier-effect. This allows not only intraburst repetition rates as high as the inverse duration of compressed femtosecond pulses with a highly scalable pulse number, but also programming of individual intraburst pulses and multi-millijoule burst-mode amplification.

Oral Tu-A1.2 13:45

LED-pumped femtosecond Cr:LiSAF regenerative amplifier — •Hussein Taleb, Pierre Pichon, Frédéric Druon, François Balembois, and Patrick Georges — Université Paris-Saclay, Institut d'Optique Graduate School, CNRS, Laboratoire Charles Fabry, 91127, Palaiseau, France

We demonstrate the first LED-pumped Cr:LiSAF regenerative amplifier, seeded by 75 fs pulses coming from a Ti :sapphire femtosecond oscillator. The amplifier delivers pulses of 1.1 mJ energy at a repetition rate of 10 Hz, on a spectrum centered at 840 nm.

Oral Tu-A1.3 14:00

Multi-Watt, mJ nanosecond pulses amplification in a Yb:LuLiF$_4$ single crystal fiber grown by micro-pulling-down — •Sara Pizzurro[1], Federico Pirzio[1], Shu Jun[3], Alberto Di Lieto[2], Mauro Tonelli[4], and Antonio Agnesi[1] — [1]Dipartimento di Ingegneria Industriale e dell'Informazione, Università di Pavia, via Ferrata 5, IT-27100, Pavia, Italy — [2]NEST Istituto Nanoscienze-CNR and Dipartimento di Fisica, Università di Pisa, Largo B. Pontecorvo 3, IT-56127 Pisa, Italy — [3]Gemmological Institute, China University of Geosciences, Wuhan 430074, China — [4]Mega Materials s.r.l and Dipartimento di Fisica, Università di Pisa, Largo B. Pontecorvo 3, IT-56127 Pisa, Italy

We present, for the first time, ns-pulses amplification in a 42-mm-long, 100-W cw-pumped, 2%–Yb^{3+}:$LuLiF_4$ birefringent single crystal fiber grown by micro-pulling-down. Seeding the amplifier with 110-ns, 180-μJ pulses at 5.2 kHz repetition-rate, in 4-passes amplification we obtained >1 mJ pulse energy (~10 kW peak power) with excellent beam quality (M^2=1.1).

Oral Tu-A1.4 14:15

Modal Reconstruction of Transverse Mode-Locked Laser Beams — •Florian Schepers[1], Tim Hellwig[1], and Carsten Fallnich[1,2] — [1]Institute of Applied Physics, University of Münster, 48149 Münster, Germany — [2]MESA + Institute for Nanotechnology, University of Twente, Enschede 7500 AE, The Netherlands

We present the modal reconstruction of a transverse mode-locked laser beam and investigate the influence of the modal power distribution and the modal phases on the spatio-temporal dynamics of the beam. Furthermore, we demonstrate the generation of a transverse mode-locked laser beam simultaneously oscillating on multiple parallel traces.

Oral Tu-A1.5 14:30

High average power, single-cycle THz generation in Lithium Niobate — •Tim Vogel[1], Samira Mansourzadeh[1], Frank Meyer[1], Dilyan Damyanov[2], Martin Saraceno[1], Jan C. Balzer[2], and Clara J. Saraceno[1] — [1]Photonics and Ultrafast Laser Science (PULS), Ruhr-University Bochum, 44801 Bochum, Germany — [2]Chair of Communication Systems, University of Duisburg-Essen, 47057 Duisburg, Germany

We demonstrate a record-high-power single-cycle THz source with 66mW of average power, based on optical rectification of a 100W-class thin-disk oscillator using the tilted-pulse front method in Lithium Niobate. We confirm the potential of this source by performing THz lensless imaging of a mixed polymer sample in reflection.

Oral Tu-A1.6 14:45

Highly efficient frequency down-conversion by optical rectification — •Claudia Gollner[1], Mostafa Shalaby[2,3], Ignas Astrauskas[1], Corinne Brodeur[2], Andrius Baltuska[1,4], and Audrius Pugzlys[1,4] — [1]Photonics Institute, TU Wien, Vienna, Austria — [2]Swiss Terahertz Research-Zurich, Techpark, Zurich, Switzerland — [3]Key Lab of Terahertz Optoelectronics, Beijing, China — [4]Center for Physical Sciences & Technology, Vilnius, Lithuania

We report on highly efficient THz generation by optical rectification in organic crystals of intense mid-IR pulses centered at 3.9 μm and 1.95 μm. Record optical- to THz conversion efficiencies exceeding 4% can be achieved, which we attribute to the suppression of multi-photon absorption.

Oral Tu-A1.7 15:00

Powerful broadband intracavity THz generation in a compact ultrafast diode-pumped laser oscillator — •Marin Hamrouni, Jakub Drs, Julian Fischer, Norbert Modsching, Valentin Wittwer, François Labaye, and Thomas Südmeyer — Laboratoire Temps Fréquence - université de Neuchâtel, Neuchâtel, Switzerland

We demonstrate an intra-cavity enhanced broadband THz source generating 160 μW within a 6-THz bandwidth through optical rectification in GaP. The laser is a simple diode-pumped Yb:CALGO Kerr-lens modelocked oscillator. We believe this is a promising approach developing broadband high-power THz sources using a compact and low-cost laser oscillator.

Tu-P1: Poster Session 1

Time: Tuesday, 15:30–17:00 Location: virtual

Poster Tu-P1.1 15:30

Detailed spectroscopic Analysis of CaF2 : Nd, X3+ , Z3+ (X, Z = Gd, La, Ce, Y, Lu, Sc) Crystals for High energy Lasers Applications — •Cesare Meroni[1], Alain Braud[1], Jean-Louis Doualan[1], Cédric Maunier[2], Denis Penninckx[2], and Patrice Camy[1] — [1]Centre de recherche sur les Ions, les Matériaux et la Photonique (CIMAP), UMR 6252, CEA-CNRS-ENSICAEN, Université de Caen, 6 Blvd Maréchal Juin, 14050 Caen, France — [2]CEA CESTA, 15 avenue des Sablières, CS 60001, 33116 Le Barp Cedex, France

In this work, we investigate the effect of co-doping CaF2:Nd3+ with different optically inactive buffer ions, namely Gd, La, Ce, Y, Lu, Sc. This detailed analysis shows the possibility to finely tailor the laser crystal spectroscopic properties making the material promising for large scale high peak power diode-pumped amplifiers.

Poster Tu-P1.2 15:30

Supercontinuum generation and optical damage of sapphire and YAG at high repetition rates — •Robertas Grigutis[1], Gintaras Tamošauskas[1], Vytautas Jukna[1], Alex Risos[2], and Audrius Dubietis[1] — [1]Laser Research Center, Vilnius University, Saulėtekio Avenue 10, LT-10223 Vilnius, Lithuania — [2]Faculty of Science, University of Auckland, Auckland, New Zealand

Optical degradation during supercontinuum generation in sapphire and YAG at high repetition rates is investigated. It is shown that the extinction of SC spectrum always correlates with third harmonic emission and serves as an early indicator of in-bulk optical damage. YAG exhibits superior robustness to optical damage compared to sapphire.

Poster Tu-P1.3 15:30

High-peak power passively Q-switched Nd:YAG/Cr4+:YAG laser for multi-point ignition of lean methane-air mixtures — Nicolae-Tiberius Vasile[1], Radu Chiriac[2], and •Nicolaie Pavel[1] — [1]National Institute for Laser, Plasma and Radiation Physics, Laboratory of Solid-State Quantum Electronics, Magurele 077125, Ilfov, Romania — [2]University Politehnica of Bucharest, Faculty of Mechanical Engineering and Mechatronics, Bucharest 060042, Romania

A passively Q-switched Nd:YAG/Cr4+:YAG laser with four beams (each delivering pulses of 3.2-mJ energy and 1-ns duration) was build and used to study multi-point ignition of lean methane-air mixtures. Increases of peak pressure and shorter combustion times have been measured for ignition at four locations in comparison with one-point ignition.

Poster Tu-P1.4 15:30

Diode bar pumped, 0.5 mJ, sub-ns laser at 1.34 μm — •Kaloyan Georgiev[1], Lyuben Petrov[1], Desislava Georgieva[1], Anton Trifonov[1,2], and Ivan Buchvarov[1] — [1]Department of Physics, Sofia University, 5 James Bourchier Blvd., Sofia, Bulgaria — [2]IBPhotonics Ltd., Plovdivsko pole 19A,Sofia, Bulgaria

We present a sub-ns (733 ps), high energy (> 0.5 mJ), high peak power (~ 1 MW), longitudinally - diode bar pumped, passively Q-switched Nd+3:YAP/V+3:YAG micro-laser oscillator at 100 Hz, generating a single mode (TEM00) beam at 1342 nm.

Poster Tu-P1.5 15:30

Femtosecond ultra-broadband non-collinear optical parametric oscillator in the visible spectral range (VIS-NOPO) — •Robin Mevert[1], Yuliya Binhammer[1], Jintao Fan[1], Thomas Binhammer[1], Christian Markus Dietrich[1], José Ricardo Andrade[1], Luise Beichert[1], and Uwe Morgner[1,2] — [1]Institut für Quantenoptik, Hannover, Germany — [2]Laser Zentrum Hannover e.V., Hannover, Germany

We demonstrate for the first time that the non-collinear optical parametric oscillator can close the gap for tuneable ultrashort laser pulses in the visible. The VIS-NOPO is directly pumped by the third harmonic of a Yb-fiber laser, which implies further scalability of the concept to reach high output powers.

Poster Tu-P1.6 15:30

Synchronously pumped picosecond Raman laser at 1172 nm based on a PbMoO4 crystal — •Milan Frank[1], Sergei N. Smetanin[2], Michal Jelínek[1], David Vyhlídal[1], Vladislav E. Shukshin[2], Petr G. Zverev[2], and Václav Kubeček[1] — [1]Czech Technical University in Prague, FNSPE, Brehova 7, 115 19 Prague 1, Czech Republic — [2]Prokhorov General Physics Institute of Russian Academy of Sciences, Vavilova 38, 119991, Moscow, Russia

We demonstrate efficient generation of the first Stokes component at 1172 nm in the synchronously pumped picosecond extracavity Raman laser based on PbMoO4 crystal. The slope efficiency of 44.7% and 25.6% were achieved under excitation polarization parallel and perpendicular to the crystal optical axis, respectively.

Poster Tu-P1.7 15:30

Third harmonic generation from thin gradient layers — •David Zuber[1,2], Ayhan Tajalli[3], Morten Steinecke[4], Marco Jupé[4], Lars Jensen[2,4], Detlef Ristau[1,2,4], and Uwe Morgner[1,2,4] — [1]Institute of Quantum Optics, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover, Germany — [2]Cluster of Excellence PhoenixD (Photonics, Optics, and Engineering-Innovation Across Disciplines), 30167, Hannover, Germany — [3]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany — [4]Laser Zentrum Hannover e.V., Hollerithallee 8, 30419 Hannover, Germany

Third harmonic generation from thin layers is known to depend strongly on the thickness of the layer. We show characterizations of dielectric layers between 0 and 750nm and their good agreement with simulations. The layer materials $\chi 3$ is estimated as well as the influence of the substrate will be discussed.

Poster Tu-P1.8 15:30

Er:YLF microchip laser for free-running and gain-switching laser operation in spectral range 2.83 μm — •Richard Švejkar, Jan Šulc, Michal Němec, and Helena Jelínková — Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering, Prague, Czech Republic

In this work we present results from microchip Er:YLF laser and gain-switching operation at wavelength 2.83 μm. Using the compact Er:YLF microchip laser allows to generate laser pulses with a duration 249 ns, repetition rate 20 Hz, pulse energy 1.8 μJ, emission wavelength 2838 nm, and peak power 7.1 W.

Poster Tu-P1.9 15:30

2.5 μm and 4.5 μm Lasing in Cr^{2+},Fe^{2+}:$Zn_{0.81}Mg_{0.19}Se$ Single Crystal under 1.73 μm Q-switched Pumping via $Cr^{2+} \rightarrow Fe^{2+}$ Energy Transfer — •Adam Riha[1], Maxim Doroshenko[2], Helena Jelinkova[1], Michal Nemec[1], Michal Jelinek[1], Nazar Kovalenko[3], and Igor Terzin[3] — [1]FNSPE Czech Technical University in Prague, Prague, Czech Republic — [2]Prokhorov General Physics Institute, Moscow, Russian Federation — [3]Institute for Single Crystals National Academy of Sciences of Ukraine, Kharkiv, Ukraine

The $Cr^{2+} \rightarrow Fe^{2+}$ energy transfer in the novel Cr^{2+},Fe^{2+}:$Zn_{0.81}Mg_{0.19}Se$ laser active medium pumped by a Q-switched Er:YLF laser at 1.73 μm resulting in the mid-infrared 4.5 μm laser oscillation is reported. Results obtained were compared with direct excitation of the Fe^{2+} ions at 2.94 μm by a Q-switched Er:YAG laser.

Poster Tu-P1.10 15:30

SHG and SFG processes at a 100 kHz picosecond diode-pumped Yb:YAG thin disk laserr — •Hana Turcicova, Ondrej Novak, Jiri Muzik, Denisa Stepankova, Martin Smrz, Antonio Lucianetti, and Tomas Mocek — HiLASE Centre, Inst. of Physics of the CAS, Dolni Brezany, Czech Republic

The user potential of a diode-pumped thin disk Yb:YAG laser running at 100 kHz repetition rate at the output up to 200 W at 1030 nm has been extended by the harmonics generation system. Results attained at 515 nm, 343 nm, 257 nm, and 206 nm wavelengths will be discussed.

Poster Tu-P1.11 15:30

Infrared and self-frequency-doubling emission characteristics of diode-pumped Nd:LGSB laser crystal — •Catalina-Alice Brandus[1], Madalin Greculeasa[1,2], Alin Broasca[1,2], Flavius Voicu[1], and Lucian Gheorghe[1] — [1]National Institute for Laser, Plasma and Radiation Physics, Magurele, Ilfov, Romania — [2]Doctoral School of Physics, University of Bucharest, Faculty of Physics, Magurele, Ilfov, Romania

We report laser emission from a diode-pumped 2.3-at.% Nd:LGSB bifunctional crystal, with 1.55 W output power at 1062 nm for 4.5-W absorbed pump power at 807 nm. Self-frequency-doubling green light at 531 nm with 13.2-mW power is obtained from Nd:LGSB cut for type I (θ= 35.3, ϕ= 60) phase-matching condition.

Poster Tu-P1.12 15:30

New Yb:LYSB bifunctional crystal for efficient near-infrared laser emission and self-frequency doubling conversion — •Alin Broasca[1,2], Madalin Greculeasa[1,2], Flavius Voicu[1], Stefania Hau[1], Gabriela Croitoru[1], Cristina Gheorghe[1], Nicolaie Pavel[1], and Lucian Gheorghe[1] — [1]National Institute for Laser, Plasma and Radiation Physics, Laboratory of Solid-State Quantum Electronics, Magurele 077125, Romania — [2]Doctoral School of Physics, University of Bucharest, Faculty of Physics, Magurele 077125, Romania

We report on the growth and characterization of La0.78Y0.32Yb0.04Sc2.86(BO3)4 - Yb:LYSB crystal as a new bifunctional laser medium. High-quality Yb:LYSB crystal with incongruent melting has been grown by the Czochralski technique. Structural, linear and nonlinear optical properties and near-infrared laser emission performances under diode-laser pumping are presented.

Poster Tu-P1.13 15:30

Enhancement of the laser emission efficiency of Yb:Y2O3 ceramics via multi-step sintering method fabrication — •George Stanciu, Flavius Voicu, Catalina-Alice Brandus, Cristina Tihon, Stefania Hau, Cristina Gheorghe, Gabriela Croitoru, and Lucian Gheorghe — National Institute for Laser, Plasma and Radiation Physics, 077125 Magurele, Romania

A multi-step sintering method was developed to obtain highly transparent 5.0 at.% Yb:Y2O3 ceramics. Laser emission at 1.03 μm with 33% slope efficiency was achieved from a 1.5 mm thick Yb:Y2O3 uncoated ceramic under quasi-continuous wave pumping at 971 nm with a fiber-coupled diode laser.

Tu-A2: Ultrafast fiber lasers and amplifiers

Chaired by Fetah Benabid, Xlim, Limoges, France

Time: Tuesday, 17:15–19:00 Location: virtual

Invited Tu-A2.1 17:15

Ultra-low-noise ultrafast fiber lasers — •Alexander M. Heidt — Institute of Applied Physics, University of Bern, Sidlerstrasse 5, 3012 Bern, Switzerland

The seeding of ultrafast fiber amplifiers with coherent all-normal dispersion fiber supercontinuum pulses is shown to be a convenient route to extend the ultra-low noise properties of mature Erbium-fiber technology to other wavebands. An order of magnitude reduction of relative intensity noise is achieved for ultrafast systems at 2 μm.

Oral Tu-A2.2 17:45

Phase stabilization of a compact all-PM mode locked Yb:fiber laser to optical frequency — •Yuxuan Ma[1], Sarper Salman[1,2], Chen Li[1], Christoph Mahnke[1], Jakob Fellinger[3], Aline S Mayer[3], Oliver H Heckl[3], Christoph M Heyl[1,2], and Ingmar Hartl[1] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany — [2]Helmholtz-Institute Jena, Fröbelstieg 3, 07743 Jena, Germany — [3]Christian Doppler Laboratory for Mid-IR Spectroscopy and Semiconductor Optics, Faculty Center for Nano Structure Research, Faculty of Physics, University of Vienna, Boltzmanngasse 5, 1090 Vienna

We demonstrate a compact all-PM Yb:fiber mode locked laser phase stabilized to optical frequency reference. Using a high speed piezo together with a large range fiber stretcher, we achieved >20 kHz servo bandwidth and suppressed the residual phase error to 0.39 rad.

Oral Tu-A2.3 18:00

Smart auto-setting mode-locked laser using an evolutionary algorithm — •Jérémie Girardot, Franck Billard, Aurélien Coillet, Edouard Hertz, and Philippe Grelu — Laboratoire ICB UMR 6303 CNRS, Photonics Dpt, Université Bourgogne—Franche-Comté, F-21000 Dijon, France

We implement experimentally an evolutionary algorithm for the self-optimization of an ultrashort fiber laser regime, based on an optimal 4-parameter tuning of intracavity parameters. We use a compound merit function combining RF power and optical spectrum both readily measured from real-time oscilloscope recording, leading to an efficient auto-setting ultrafast laser.

Oral Tu-A2.4 18:15

Characterization of square pulses in passively mode-locked fiber laser — •Meriem Kemel[1], Mohamed Salhi[1], Georges Semaan[1], Ahmed Nady[1,2], and François Sanchez[1] — [1]Laboratoire de Photonique d'Angers, 2 Bd de Lavoisier, 49045 - Angers, France — [2]Department of Physics, Faculty of Science, Beni-Suef University, 62511 - Beni-Suef, Egypt

In passively mode-locked fiber laser, dissipative soliton resonance (DSR) regime manifests a square pulse with no fine structures and the pulse energy increases indefinitely without any wave-breaking. Here, we demonstrated an experimental setup to investigate the coherence of square pulses and thereby verifying whether it is DSR or not.

Oral Tu-A2.5 18:30

Research on amplification of ultrashort laser pulses at 1.03 μm in gain-managed nonlinearity regime — •Dorota Tomaszewska and Grzegorz Soboń — Laser & Fiber Electronics Group, Wroclaw University of Science and Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland

We demonstrate a setup for amplification in gain-managed nonlinearity regime. The setup, built using Ytterbium-doped fiber, provides 71 nJ pulses at 1083 nm with 45 nm of width. The pulse can be compressed and used as a pump for nonlinear processes.

Oral Tu-A2.6 18:45

REPUSIL-based Large Mode Area fiber designs for megawatt peak power picosecond tapered fiber amplifiers — Martin Leich[1], André Kalide[1], Martin Lorenz[1], Tina Eschrich[1], Adrian Lorenz[1], Jens Kobelke[1], Katrin Wondraczek[1], Dörte Schönfeld[2], Andreas Langner[2], Clemens Schmitt[2], Jaqueline Plass[2], Gerhard Schötz[2], and •Matthias Jäger[1] — [1]Leibniz Institute of Photonic Technology (IPHT) Jena, 07745 Jena, Germany — [2]Heraeus Quarzglas GmbH & Co. KG, 63450 Hanau, Germany

We investigate various fiber designs based on powder sinter technology with a core diameter of 35 to 60μm in terms of their suitability for high peak power amplification and achievable beam quality in a tapered amplifier configuration. We demonstrate near diffraction-limited beam quality of up to 2 MW peak power.

We-Symp1: Lasers for space: Ranging

Chaired by Philippe Grelu, University Bourgogne-Franche-Comté, Dijon, France

Time: Wednesday, 8:30–10:15 Location: virtual

Keynote We-Symp1.1 8:30

Lasers and Optics for the Laser Interferometer Space Antenna (LISA) — •Nelson Christensen — Artemis, Observatoire de la Côte d'Azur, Université Côte d'Azur, Nice, France

LISA will be a large-scale space mission to detect gravitational waves. LISA will observe the entire universe directly with gravitational waves. This talk will summarize the LISA Mission, with an emphasis on the complex laser, optical and interferometric systems that must operate over a baseline of 2.5 million km.

Oral We-Symp1.2 9:15

High Resolution Mid Infrared Up-Conversion LIDAR — •Max Widarsson[1], Markus Henriksson[2], Patrick Mutter[1], Carlota Canalias[1], Valdas Pasiskevicius[1], and Fredrik Laurell[1] — [1]Department of Applied Physics, Royal Institute of Technology, Stockholm, Sweden — [2]Swedish Defence Research Agency, Linköping, Sweden

Intra-Cavity Up-conversion of 2.4 μm pulses to 737 nm was performed inside a Nd:YVO4 laser operating at 1064 nm, which allowed for range determination measurements with conventional Si-based detectors. A temporal resolution of 42 ps was achieved, allowing distinguishability between targets separated by a few millimetres.

Oral We-Symp1.3 9:30

Parametric source for DIAL applications, pumped by a single-frequency, nanosecond, multi-mJ, 5 kHz hybrid master oscillator power amplifier — Thomas Hamoudi[1,2], Xavier Délen[2], Jean-Michel Melkonian[1], •Myriam Raybaut[1], Jean-Baptiste Dherbecourt[1], Antoine Godard[1], and Patrick Georges[2] — [1]DPHY, ONERA, Université Paris Saclay, F-91123 Palaiseau – France — [2]Université Paris-Saclay, Institut d'Optique Graduate School, CNRS, Laboratoire Charles Fabry, 91127, Palaiseau, France

We present an innovative parametric source for differential absorption lidar. A single frequency optical parametric oscillator, pumped by a fiber laser and tuned by pump frequency tuning, is amplified using a parametric amplifier pumped by pulses from an hybrid fiber/bulk multi-mJ, 15 ns, single-frequency pulses at 5 kHz.

Invited We-Symp1.4 9:45

Laser Ranging to Satellites and Space Debris — •Georg Kirchner, Michael Steindorfer, Peiyuan Wang, and Franz Koidl — Austrian Academy of Science, Space Research Institute

More than 40 Satellite Laser Ranging (SLR) stations around the world measure distances to retro-reflector-equipped satellites up to the geostationary orbit, determining their orbits with an accuracy of up to few millimetres. In addition, this technique now is also used to range to space debris targets.

We-Symp2: Lasers for space: Communications

Chaired by Philippe Grelu, University Bourgogne-Franche-Comté, Dijon, France

Time: Wednesday, 10:30–12:00 Location: virtual

Invited We-Symp2.1 10:30

New photonics for improved Space Quantum Communications — •Paolo Villoresi[1], Costantino Agnesi[1], Francesco Vedovato[1], Luca Calderaro[1], Marco Avesani[1], Andrea Stanco[1], Alessia Scriminich[1], Mujtaba Zahidi[1], Hamid Tebyanian[1], Giulio Foletto[1], Francesco Picciariello[1], Francesco Santagiustina[1], and Giuseppe Vallone Vallone[1,2] — [1]Dipartimento di Ingegneria dell'Informazione, Università di Padova, via Gradenigo 6B, 35131 Padova, Italy — [2]Dipartimento di Fisica e Astronomia, Università di Padova, via Marzolo 8, 35131 Padova, Italy

The daylight QKD for space links leveraging latest photonics technology is described, with the reduction of the qubit preparation errors, aiming at the most pure transmitter for high efficiency key rate. Integrated photonics platform was also demonstrated as suitable for daylight QKD, with a remarkable increase in efficiency and compactness.

Oral We-Symp2.2 11:00

Molecular Quantum Wakes for Clearing Fog — •Malte C. Schroeder[1], Ilia Larkin[2], Thomas Produit[1], Eric W. Rosenthal[3], Howard Milchberg[2], and Jean-Pierre Wolf[1] — [1]University of Geneva, Geneva, Switzerland — [2]University of Maryland, College, USA — [3]United States Naval Research Laboratory, Washington, USA

Fog is a major obstacle for free-space optical communication. In our work we introduce a novel approach for clearing optically transparent paths through fog via the opto-mechanical displacement of droplets through molecular quantum wakes in air. Compared to conventional methods our technique seems not to be limited by spatial restrictions.

Oral We-Symp2.3 11:15

Mid-infrared Two-Photon Interference and Entanglement — •Adetunmise Charles Dada[1], Taylor Shields[1], Shashi Prabhakar[1,2], Mehdi Ebrahim[1], Gregor G. Taylor[1], Dmitry Morozov[1], Kleanthis Erotokritou[1], Shigehito Miki[3,4], Masahiro Yabuno[3], Hirotaka Terai[3], Corin Gawith[5,6], Michael Kues[7], Lucia Caspani[8], Robert H. Hadfield[1], and Matteo Clerici[1] — [1]James Watt School of Engineering, University of Glasgow, Glasgow, G12 8QQ, UK — [2]Photonics Laboratory, Physics Unit, Tampere University, Tampere, FI-33720, Finland — [3]Advanced ICT Research Institute, National Institute of Information and Communications Technology, 588-2 Iwaoka, Nishi-ku, Kobe, Hyogo 651-2492, Japan — [4]Graduate School of Engineering Faculty of Engineering, Kobe University, 1-1 Rokkodai-cho, Nada-ku, Kobe-city, Hyogo 657-0013, Japan — [5]Covesion Ltd, Unit A7, The Premier Centre, Premier Way, Romsey, Hampshire SO51 9DG, UK — [6]Optoelectronics Research Centre, University of Southampton — [7]Hannover Center for Optical Technologies (HOT), Leibniz University Hannover, Hannover, Germany — [8]Institute of Photonics, Department of Physics, University of Strathclyde, Glasgow G1 1RD, UK

We demonstrate two-photon interference and polarization entanglement at 2090 nm. This novel quantum light source constitutes a crucial leap towards free-space mid-infrared quantum communication systems in a spectral region with high atmospheric transparency and reduced solar background.

Invited We-Symp2.4 11:30
Laser-based Time Transfer through Free-space Links — •Ivan Prochazka, Josef Blazej, Tereza Flekova, and Jan Kodet — Czech Technical University in Prague, Czech Republic

We are reporting on a new approach to an optical two-way free space time transfer which is based on signals of individual photons. This approach enables to reach timing stabilities on a sub-ps level and systematic errors as low as units of ps using existing electro-optic technologies.

We-A1: Few-cycle pulse generation and application

Chaired by Uwe Morgner, Leibniz University, Laser Zentrum, Hannover, Germany

Time: Wednesday, 13:30–15:15 Location: virtual

Keynote We-A1.1 13:30
ATTOSECOND METROLOGY 2.0, From Tracking Electronic Motions to Detecting Cancer — •Ferenc Krausz — Max Planck Institute of Quantum Optics, Garching and Ludwig-Maximilians-Universität München, Munich, Germany

Sub-femtosecond current injection into wide-gap materials can directly probe ultrafast electron phenomena in condensed matter systems and also be used for sampling the electric field of light. This opens the door for real-world applications, such as early cancer detection by measuring miniscule changes of the molecular composition of blood via field-resolved vibrational molecular fingerprinting.

Oral We-A1.2 14:15
In-situ measurement of delay for the Xe giant plasmonic resonance — •Dong Hyuk Ko[1], Graham G. Brown[1], Chunmei Zhang[1], and Paul B. Corkum[1,2] — [1]University of Ottawa, Ottawa, Canada — [2]National Research Council of Canada, Ottawa, Canada

We demonstrate time-resolved spectroscopy of a resonant process by applying in-situ measurement method. It probes ultrafast multi-electron response during the recollision of high harmonic generation. Consequently, we measure the delay shift around the resonant peak of XUV radiations and reveal the time-dependent relaxation of XUV emission due to multi-electron interactions.

Oral We-A1.3 14:30
Few-cycle mid-infrared pulses from $BaGa_2GeSe_6$ — Ugaitz Elu[1], •Luke Maidment[1], Lenard Vamos[1], Tobias Steinle[1], Florian Haberstroh[1], Valentin Petrov[2], Valeriy Badikov[3], Dmitrii Badikov[3], and Jens Biegert[1,4] — [1]ICFO–Institut de Ciencies Fotoniques, The Barcelona Institute of Science and Technology, 08860 Castelldefels, Barcelona, Spain — [2]Max-Born-Institute for NonlinearOptics and Ultrafast Spectroscopy, 2AMax-Born-Str., D-12489 Berlin,Germany — [3]High Technologies Laboratory, Kuban State University, Stavropolskaya Str. 149, 350040 Krasnodar, Russia — [4]ICREA–Institució Catalana de Recerca i Estudis Avançats, 08010 Barcelona, Spain

The newly developed nonlinear crystal $BaGa_2GeSe_6$ (BGGSe) is used to generate carrier-envelope-phase stable 21 pJ, 100-MHz pulses with a spectral bandwidth covering 5.8 to 8.5 μm. A pulse duration of 91 fs is measured using electro optic sampling. Numerical simulations demonstrate BGGSe's potential for generating octave spanning mid-infrared pulses.

Oral We-A1.4 14:45
Yb:CALGO bulk oscillator generating ultrashort pulses at high efficiency by cross-polarized optical pumping — •François Labaye[1], Valentin J. Wittwer[1], Norbert Modsching[1], Olga Razskazovskaya[1], Eric Cormier[2,3], and Thomas Südmeyer[1] — [1]Laboratoire Temps-Fréquence, Institut de Physique, Université de Neuchâtel, Avenue de Bellevaux 51, 2000 Neuchâtel, Switzerland — [2]Laboratoire Photonique, Numérique et Nanosciences, UMR 5298, CNRS-IOGS-Université Bordeaux, 33400 Talence, France — [3]Institut Universitaire de France (IUF), 1 rue Descartes,75231 Paris

Standard collinearly pumped Yb-doped ultrafast laser oscillators with dichroic mirrors are intrinsically limited when the broadband spectrum extends towards the pump wavelength. Here we demonstrate a novel pumping scheme relaxing this constraint and enabling substantially higher efficiencies, shorter pulses while opening new opportunities for compact high-power few-cycle Yb-doped laser oscillators.

Oral We-A1.5 15:00
33 W OPCPA at 10 kHz repetition rate with four cycle pulse duration at 2.1 μm based on a single pump laser — •Anke Heilmann, Martin Bock, Lutz Ehrentraut, Stefan Eisebitt, and Matthias Schnürer — Max-Born-Institut, Max Born Straße 2a, 12489 Berlin, Germany

Based on a single pump laser we present a 33 W OPCPA system operating at 2.1 μm and 10 kHz repetition rate. Using BiBO and YCOB as nonlinear crystals, the output spectrum has a FWHM of 430 nm. This allows to amplify four cycle pulses with duration of 25 fs.

We-A2: Fiber and waveguide resonators and characterization

Chaired by Mark Dubinskii, ARL, Maryland, USA

Time: Wednesday, 15:30–17:15 Location: virtual

Oral We-A2.1 15:30

Phase shifts during mirror transmission and reflection in laser resonators — •Jerry Yeung and Markus Pollnau — University of Surrey, Guildford, United Kingdom

Two conventions exist for phase shifts in transmission or reflection at optical interfaces: a pi phase shift during reflection from the lower-refractive-index medium versus a pi/2 phase shift during transmission. For double Fabry-Perot resonators, we confirm the former but discard the latter, with consequences for Bragg gratings and distributed-feedback resonators.

Oral We-A2.2 15:45

Reflection, transmission, and loss curves and intensity distributions in distributed-feedback resonators with propagation losses — •Jerry Yeung and Markus Pollnau — University of Surrey, Guildford, United Kingdom

With a recursive method previously applied to single Fabry-Perot resonators, we obtain exact electric-field and intensity distributions in multi-resonator structures, such as Bragg gratings and distributed-feedback (DFB) resonators, with propagation losses. Reflection, transmission, propagation-loss curves, and light-intensity distributions are calculated for DFB resonators. Consequences for DFB lasers are discussed.

Oral We-A2.3 16:00

Enhanced linewidth narrowing in a distributed-feedback resonator — •Cristine Kores[1], Dimitri Geskus[1], Meindert Dijkstra[2], and Markus Pollnau[3] — [1]KTH – Royal Institute of Technology, Kista, Sweden — [2]University of Twente, Enschede, The Netherlands — [3]University of Surrey, Guildford, United Kingdom

Narrowing of a resonance line due to gain is a well-known phenomenon. In an Al2O3:Yb3+ channel-waveguide distributed-feedback resonator we measured the resonance linewidth and the gain as a function of pump power until the laser threshold. The resonance linewidth narrows significantly faster with increasing gain than predicted by the theory.

Oral We-A2.4 16:15

The C-cavity, a highly versatile and simple laser design — •Robert Lindberg[1], Fredrik Laurell[1], Krister Fröjdh[2], and Walter Margulis[3] — [1]Department of Applied Physics, Royal Institute of Technology, 10691 Stockholm, Sweden — [2]Proximion AB, Skalholtsgatan 10, SE 164 40 Kista, Sweden — [3]Department of Fiber Optics, RISE Acreo, 164 40 Kista, Sweden

We present a novel cavity design for tunable pulsed laser operation. The extremely simple layout only employs a semiconductor optical amplifier, a chirped fiber Bragg grating and an output coupler. A tuning range of 35 nm as well as time-multiplexed multi-wavelength operation is demonstrated.

Oral We-A2.5 16:30

Coherence and power thresholds of continuous-wave lasers — •Markus Pollnau[1] and Marc Eichhorn[2] — [1]University of Surrey, Guildford, United Kingdom — [2]Karlsruhe Institute of Technology, Karlsruhe, Germany

Consideration of the spontaneous-emission rate modifies the threshold behavior and slope efficiency of a cw laser. We introduce new definitions of the coherence threshold and the power threshold as functions of the pump rate and explain them by a numerical example. The coherence threshold is lower than the power threshold.

Oral We-A2.6 16:45

Using the Variable Pump Intensity method to measure optical gains and unveil photophysical and photonic phenomena in active waveguides — •Luis Cerdán[1], Marco Anni[2], Maria Luisa De Giorgi[2], Pedro G. Boj[3], and María Angeles Díaz-García[4] — [1]Instituto de Química Física "Rocasolano", Consejo Superior de Investigaciones Científicas (CSIC), Madrid, Spain — [2]Dipartimento di Matematica e Fisica "Ennio de Giorgi", Universitá del Salento, Lecce, Italy — [3]Departamento de Óptica, Farmacología y Anatomía, Instituto Universitario de Materiales de Alicante y Unidad Asociada UA-CSIC, Universidad de Alicante, Alicante, Spain — [4]Departamento de Física Aplicada, Instituto Universitario de Materiales de Alicante y Unidad Asociada UA-CSIC, Universidad de Alicante, Alicante, Spain

An analytic expression describing the growth of the Amplified Spontaneous Emission intensity as a function of pump density was recently reported. We will show that it enables the simultaneous retrieval of losses and optical gain spectra from a single experiment and helps unveiling photonic and photophysical properties of active waveguides.

Oral We-A2.7 17:00

Quantitative analysis of cooperative upconversion in Al2O3:Yb3+ waveguides on silicon — Pavel Loiko[1], Laura Agazzi[2], Cristine Kores[3], Meindert Dijkstra[2], Dimitri Geskus[3], and •Markus Pollnau[1] — [1]University of Surrey, Guildford, United Kingdom — [2]University of Twente, Enschede, The Netherlands — [3]KTH – Royal Institute of Technology, Kista, Sweden

Ridge waveguides in amorphous Al2O3:Yb3+ are fabricated by reactive co-sputtering and reactive-ion etching. Their spectroscopic properties, including lifetimes, cooperative upconversion, and optical gain are studied. Results are explained based on a rate-equation model comprising two distinct ion classes: single ions and paired or clustered ions. The latter undergo cooperative upconversion.

We-A3: Novel laser materials

Chaired by Francois Balembois, Institut d'Optique, Paris, France

Time: Wednesday, 17:30–19:15 Location: virtual

Oral We-A3.1 17:30

Comparative study of Ho:Y3Al5O12 and Ho:Y2O3 transparent ceramics synthesized from laser ablated nanopowders — •Liza Basyrova[1], Roman Maksimov[2,3], Vladislav Shitov[2], Alexander Khubetsov[4], Olga Dymshits[4], Mikhail Baranov[1], Florent Starecki[5], Patrice Camy[5], and Pavel Loiko[5] — [1]ITMO University, St. Petersburg, Russia — [2]Institute of Electrophysics, Ural Branch of the Russian Academy of Sciences, Ekaterinburg, Russia — [3]Ural Federal University named after the first President of Russia B.N. Yeltsin, Ekaterinburg, Russia — [4]Vavilov State Optical Institute, St. Petersburg, Russia — [5]Centre de recherche sur les Ions, les Matériaux et la Photonique (CIMAP), UMR 6252 CEA-CNRS-ENSICAEN, Université de Caen Normandie, Caen, France

Transparent ceramics of Ho:Y3Al5O12 and Ho:Y2O3 are fabricated by vacuum sintering at 1780 ˚C for 20 hours using TEOS / ZrO2 as sintering aids from nanopowders produced by laser ablation. Their structure, optical and spectroscopic properties are studied. The transition probabilities and non-radiative rates for Ho3+ ions are evaluated.

Oral We-A3.2 17:45

High-power, wavelength-tunable red-diode-pumped Alexandrite laser — •Goronwy Tawy[1], Ara Minassian[2], and Michael J. Damzen[1] — [1]Photonics Group, The Blackett Laboratory, Dept. of Physics, Imperial College London, London SW7 2AZ, UK — [2]Unilase Ltd, 60 Grays Inn Road, Unit LG04, London WC1X 8AQ, UK

We demonstrate a 7.4W diode-pumped Alexandrite laser with diffraction-limited beam quality (TEM00) and multi-watt level wavelength tuning with >1W at 730-800nm demonstrated for the very first time. To the best of our knowledge, we believe this result to be the highest power diode-pumped vibronic laser in the 700-800nm range.

Oral We-A3.3 18:00

Laser emission of Tb^{3+}:BaY_2F_8 at 581.1 nm in the yellow range — •Elena Castellano-Hernández[1], Eugenio Damiano[2], Mauro Tonelli[2], and Christian Kränkel[1] — [1]Center for Laser Materials, Leibniz-Institut für Kristallzüchtung (IKZ), Berlin, Germany — [2]Dipartimento di Fisica, Università di Pisa and MEGA Materials s.r.l., Pisa, Italy

We report on the first laser operation of Tb^{3+} in BaY_2F_8. Laser emission at 581.1 nm in the yellow was achieved with a maximum output power of 147 mW and a maximum slope efficiency of 16%. This work represents the first direct emission of a solid-state laser at 581 nm.

Oral We-A3.4 18:15

Prospects of UV diode pumping of Tb-based solid-state lasers with visible emission — •Sascha Kalusniak, Hiroki Tanaka, Elena Castellano-Hernández, and Christian Kränkel — Leibniz-Institut für Kristallzüchtung, Berlin, Germany

To investigate the suitability of UV-pumping of Tb^{3+}-lasers, we determined concentration dependent spectroscopic properties of Tb^{3+}-doped crystals. In particular, we report on energy transfer from the $^5D_3$ level into the upper laser level $^5D_4$ by cross-relaxation under 380-nm pumping. We further discuss excited state absorption in Tb^{3+}-doped crystals.

Oral We-A3.5 18:30

65-fs pulse generation from a SESAM mode-locked Tm,Ho:CLNGG laser at 2.07 μm — Yongguang Zhao[1,2], Zhongben Pan[1,3], •Li Wang[1], Weidong Chen[1], Yicheng Wang[1], Soile Suomalainen[4], Antti Härkönen[4], Mircea Guina[4], Pavel Loiko[5], Xavier Mateos[6], Uwe Griebner[1], and Valentin Petrov[1] — [1]Max-Born-Institute for Nonlinear Optics and Short Pulse Spectroscopy, 2A Max-Born-Str., 12489 Berlin, Germany — [2]Jiangsu Key Laboratory of Advanced Laser Materials and Devices, Jiangsu Normal University, Xuzhou 221116, China — [3]Institute of Chemical Materials, China Academy of Engineering Physics, Mianyang 621900, China — [4]Optoelectronics Research Centre, Tampere University of Technology, P.O. Box 692, 33101 Tampere, Finland — [5]Centre de Recherche sur les Ions, les Matériaux et la Photonique (CIMAP), UMR 6252 CEA-CNRS-ENSICAEN, Université de Caen, 6 Boulevard du Maréchal Juin, 14050 Caen Cedex 4, France — [6]Universitat Rovira i Virgili, Física i Cristal·lografia de Materials i Nanomaterials (FiCMA-FiCNA), 43007 Tarragona, Spain

Here we report on a GaSb-based SESAM mode-locked Tm,Ho:CLNGG laser at 2073 nm. Pulse duration as short as 65 fs, i.e. 9 optical cycles, is obtained with a repetition rate of ~85 MHz and a maximum average output power of 33 mW.

Oral We-A3.6 18:45

High-power CW Ho:YAG thin-disk laser and first SESAM-modelocking — •Sergei Tomilov, Tim Vogel, Martin Hoffmann, Yicheng Wang, and Clara J. Saraceno — Photonics and Ultrafast Laser Science, Ruhr-Universität Bochum, Universitätsstrasse 150, 44801 Bochum, Germany

We demonstrate a Ho:YAG thin-disk oscillator operating in fundamental-mode CW regime, delivering a record output power of 96 W and preliminary SESAM-modelocking results. To the best of our knowledge, this is the highest CW power achieved from a single-mode laser with a Ho-doped active medium.

Oral We-A3.7 19:00

Growth, spectroscopy and diode-pumped laser operation of acentric Yb:KGd(PO3)4 crystal — Shanming Li[1,2], •Anna Volokitina[1,3], Rosa Maria Solé[1], Pavel Loiko[4], Valentin Petrov[5], Uwe Griebner[5], Yin Hang[2], Francesc Díaz[1], Magdalena Aguiló[1], and Xavier Mateos[1] — [1]Universitat Rovira i Virgili (URV), FiCMA-FiCNA-EMaS, Marcel.li Domingo 1, 43007 Tarragona, Spain — [2]Laboratory of Micro-Nano Photonic and Optoelectronic Materials and Devices, Key Laboratory of Materials for High Power Laser, Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, 201800 Shanghai, China — [3]ITMO University, 49 Kronverkskiy Pr., 197101 St. Petersburg, Russia — [4]CIMAP, UMR 6252 CEA-CNRS-ENSICAEN, Université de Caen Normandie, 6 Boulevard du Maréchal Juin, 14050 Caen, France — [5]Max-Born-Institute for Nonlinear Optics and Short-Pulse Spectroscopy, 2A Max-Born-Str., 12489 Berlin, Germany

We report on the top-seeded solution growth, polarized spectroscopy and first diode-pumped laser operation of a bifunctional acentric crystal, monoclinic Yb:KGd(PO3)4. A compact diode-pumped laser generated a maximum output power of 1.57 W at 1040.7 nm and with a slope efficiency of 44.4%, a linear polarization and fundamental-mode output.

We-P2: Poster Session 2

Time: Wednesday, 19:30–21:00 Location: virtual

Poster We-P2.1 19:30

Full-energy, vacuum-compatible, single-shot pulse characterization method for petawatt-level ultra-broad bandwidth lasers using spatial sampling — •Benjamin Webb, Seung-Whan Bahk, Ildar A. Begishev, Christophe Dorrer, Chengyong Feng, Cheonha Jeon, Michael Spilatro, Richard Roides, Jonathan Zuegel, and Jake Bromage — Laboratory for Laser Energetics, University of Rochester, Rochester, NY, USA

A novel method for monitoring single-shot pulse duration of large-aperture beams at full energy in vacuum is investigated on the newly-built MTW-OPAL 0.5 PW system. Spatial sampling of the spectral phase across a 90 mm beam and comparisons of full to sub-aperture SPIDER measurements determine the accuracy of this approach.

Poster We-P2.2 19:30

Hybrid Electronically Addressed Random Fibre Laser — •Walter Margulis[1], Avishek Das[2], Jean Pierre von der Weid[3], and Anderson S. L. Gomes[2] — [1]Dept. Fiber Optics, RISE Research Institutes of Sweden, 16440 Stockholm Sweden — [2]Physics Dept, Federal Univ. Pernambuco UFPE, Recife, 50670-901, PE, Brazil — [3]Center for Telecommunication Studies, Pontifical Catholic University of Rio de Janeiro, 22451-900, Rio de Janeiro, RJ, Brazil

A random fibre laser with two gain media is described. A semiconductor optical amplifier is gated in nanoseconds, generating optical pulses which are amplified and backscatter along an Erbium-doped fibre, providing distributed feedback. The repetition rate of the SOA defines which section of the EDF resonates and is electronically addressed.

Poster We-P2.3 19:30

Fundamental mode field evolution in a tapered optical fibre — •Jaime R. Ek-Ek[1], Fernando Martinez-Pinon[1], Herman L. Offerhaus[2], and Jose A. Alvarez.Chavez[2] — [1]Instituto Politecnico Nacional, Centro de Investigacion e Innovacion Tecnologica, Azcapotzalco, Ciudad de Mexico, Mexico — [2]Optical Sciences Group, University of Twente, Enschede, The Netherlands

Mode field, spot size, adiabatic shape and central peak intensity evolution are calculated for different points along with the transition of an adiabatic optical fibre taper from standard size down to micron (1 μm external diameter) and sub-micron size (down to 440 nm fibre diameter) at 1550 nm operation wavelength.

Poster We-P2.4 19:30

Numerical study of effect of bending and twist on pump absorption in octagonal double-clad fiber — •Martin Grábner[1], Kanagaraj Nithyanandan[2], Pavel Peterka[1], Pavel Koška[1], Ali A. Jasim[1], and Pavel Honzátko[1] — [1]Institute of Photonics and Electronics, Czech Academy of Sciences, Praha, Czech Republic — [2]Optoelectronic Research centre, University of Southampton, Southamtpon, United Kingdom.

The double-clad fiber with the octagonal inner cladding is analyzed numerically using the FEM-BPM method. The pump absorption characteristics dependent on the fiber bending radius and twist rate are obtained for 5 geometries with wavelength 1950 nm. The mode scrambling by twist is less effective in smaller cross sections.

Poster We-P2.5 19:30

Numerical and Experimental Optimization of Fiber-Coupling Conditions for Spontaneous Parametric Down-Conversion — •Tobias Bernd Gäbler[1,2], Rana Sebak[1,3], Susana Plascencia Orozco[1], Markus Gräfe[1], and Fabian Oliver Steinlechner[1] — [1]Fraunhofer Institute for Applied Optics and Precision Engineering IOF, Albert-Einstein-Straße 7, D-07745 Jena, Germany — [2]Friedrich-Schiller University Jena, Institute of Applied Physics, Albert-Einstein-Straße 15, D-07745 Jena, Germany — [3]Friedrich-Schiller University Jena, Abbe School of Photonics, Albert-Einstein-Straße 5, D-07745 Jena, Germany

Our theoretical and experimental research addresses the fiber coupling of photon pairs generated by SPDC. It shows the trade-off between heralding and collection efficiency in consideration of arbitrary Gaussian modes, beam waists, crystal lengths and SPDC types.

Poster We-P2.6 19:30

Post-treatment of DBR fibre lasers for enhanced beat-frequency in dual-polarization operation — •Marie Guionie[1], Marc Brunel[1], Goulc'hen Loas[1], Emmanuel Pinsard[2], Laurent Lablonde[2], and Benoit Cadier[2] — [1]Univ Rennes, CNRS, Institut FOTON UMR 6082 — [2]iXblue Photonics, Lannion

UV photo-ablation provides an efficient and reproducible means to control the birefringence of a dual-frequency DBR fiber laser. The resulting beat note can be finely tuned by real-time measurement during the process from typically 100 MHz to about 6 GHz, independently of the active medium length.

Poster We-P2.7 19:30

Estimation of Interlock Requirements for High-Power EYDFA — •Phillip Booker[1], Omar De Varona[1], Michael Steinke[1,2], Peter Wessels[1,2], Jörg Neumann[1], and Dietmar Kracht[1,2] — [1]Laser Zentrum Hannover, Hollerithallee 8, 30419 Hanover, Germany — [2]Cluster of Excellence QuantumFrontiers, Welfengarten 1, 30167 Hanover, Germany

We studied EYDFA interlock requirements for a seed failure with ASE-data and a time-dependent model. We computed the temporal evolution of the energy levels to take place within tens to hundreds of microseconds and concluded that a suitable interlock has to address these time scales to avoid catastrophic damage.

Poster We-P2.8 19:30

Influences on the direction probabilities for the direction instability phenomenon in fiber ring lasers — •Muhammad A. Arshad[1,2], Arni Pratiwi[1,2], Alexander Hartung[1], and Matthias Jäger[1] — [1]Leibniz-Institute of Photonic Technology, Albert-Einstein-Straße 9, 07747 Jena, Germany — [2]Friedrich Schiller University, Faculty of Physics and Astronomy, Max-Wien-Platz 1, 07743 Jena, Germany

Direction instability is a new phenomenon where a reciprocal fiber ring laser initially operates in both directions but spontaneously turns of one lasing direction and switches to unidirectional mode at above a threshold. This final direction is not predefined. We report on the possibilities to influence this final direction.

Poster We-P2.9 19:30

Flat axial intensity profile in the Bessel beam for beam shaping applications in laser systems — Pavel Gotovski[1], Paulius Šlevas[1,2], Orestas Ulčinas[1,2], Ernestas Nacius[1,2], •Benas Stanionis[1], Sergej Orlov[1], Vytautas Jukna[1,3], and Titas Gertus[1,4] — [1]Coherent Optics Laboratory, Center for Physical Sciences and Technology, Sauletekeio ave 3, LT-10257, Vilnius, Lithuania — [2]Workshop of Photonics, Moksliininku st. 6A, LT-08412,Vilnius, Lithuania — [3]Laser research center, Vilnius University, Sauletekio av. 10, LT- 10223, Vilnius, Lithuania — [4]Light Conversion, Keramiku st. 2B, LT-10234, Vilnius, Lithuania

A study on enabling flat axial intensity profile in the nondiffracting Bessel beam is presented. Experimental implementation of such beams is made possible by axicon-type optical converters, which we inscribe in the glass by femtosecond laser pulses.

Poster We-P2.10 19:30

Beam-Shaping Optimization of the diode bar end-pumped laser — •Lyuben Petrov, Kamen Velev, Kaloyan Georgiev, and Ivan Buchvarov — Physics Faculty, Sofia University, Sofia, Bulgaria

In this report we present a numerical method, based on a generalized ABCD matrix law, for optimization of a beam shaper, which would equalize the beam quality of both the slow and fast axes of a diode laser bar, with little loss of brightness.

Poster We-P2.11 19:30

Factor-of-two decrease in laser linewidth near threshold — •Markus Pollnau — University of Surrey, Guildford, United Kingdom

The quantum-mechanically predicted additional factor-of-two decrease in laser linewidth near threshold was interpreted as damping of spontaneous-emission-induced amplitude fluctuations by relaxation oscillations. However, such fluctuations would violate energy conservation. We propose that the linewidth decrease is due to decreasing non-orthogonality of the counter-propagating modes at the laser frequency and polarization.

Poster We-P2.12 19:30

All-Bulk Pulse Stretching and Compression for Near Infrared Optical Parametric Amplifiers — •Giedre Archipovaite and Gabriel Karras — Central Laser Facility, STFC

We present a novel approach of designing OPAs in the NIR, where all the pulse chirp is controlled in bulk materials. This has a potential to increase the robustness and simplicity of the system.

Poster We-P2.13 19:30

Dispersion management of all-PM NALM-based Er-doped fiber laser — •Zbigniew Laszczych and Grzegorz Soboń — Laser & Fiber Electronics Group, Wrocław University of Science and Technology, Wybrzeże S. Wyspiańskiego 27, 50-370 Wrocław, Poland

We present experimental study on performance of an all polarization-maintaining Er-doped femtosecond laser regarding net cavity dispersion. Comprehensive characterization of both output ports including second harmonic frequency resolved optical gating technique (SHG FROG) was performed to investagate capability of such a device as a source of unchirped ultrashort pulses.

Th-P3: Poster Session 3

Time: Thursday, 8:30–10:00 Location: virtual

Poster Th-P3.1 8:30

Nonlinear plasmonic metasurfaces assisted laser mode locking — •Lei Zhang[1,2], Jiyong Wang[1,2], Aurelien Coillet[3], Philippe Grelu[3], Benoit Cluzel[3], and Min Qiu[1,2] — [1]Key Laboratory of 3D Micro/Nano Fabrication and Characterization of Zhejiang Province, School of Engineering, Westlake University, 18 Shilongshan Road, 310024 Hangzhou, Zhejiang Province, China — [2]Institute of Advanced Technology, Westlake Institute for Advanced Study, 18 Shilongshan Road, 310024 Hangzhou, Zhejiang Province, China — [3]Laboratoire Interdisciplinaire Carnot de Bourgogne, Université Bourgogne Franche-Comté, 9 avenue Alain Savary, 21078 Dijon, France

Nonlinear plasmonics, combining nonlinear and sub-wavelength optics, is an emerging field. However, practical applications remain limited to date. Here, we implement plasmonic saturable metasurfaces into a fiber laser architecture to achieve soliton mode locking. This work opens new perspectives towards future applications where tunable nonlinear transfer functions are needed.

Poster Th-P3.2 8:30

CW Nd:YVO4 disk laser with multipoint diode pumping and in-phase super-mode lasing — •Denis Guryev, Dmitri Nikolaev, and Vladimir Tsvetkov — Prokhorov General Physics Institute, Russian Academy of Sciences, 38 Vavilov Str., 119991 Moscow, Russian Federation

In-phase super-mode lasing regime in solid-state disk laser with nine-beam diode pumping was demonstrated, divergence of output radiation was corresponded to diffraction limited by total aperture of all lasing spots. Super-mode lasing conditions were determined and explanation of this regime was given.

Poster Th-P3.3 8:30

Investigation of sources of subnanosecond pulses of the visible spectral range for medical systems — •Irina V. Zhluktova[1], Vladimir A. Kamynin[1], Nataliya R. Arutyunyan[1,2], Anatoly S. Pozharov[1], Anton I. Trikshev[1], Serafima A. Filatova[1], Elena D. Obraztsova[1], and Vladimir B. Tsvetkov[1] — [1]General Physics Institute of Russian Academy of Scinces, ul. Vavilova 38, 119991 Moscow, Russia — [2]National Research Nuclear University »MEPHi«, Kashirskoe hwy. 31, 115409 Moscow, Russia

Long-cavity ytterbium-doped fiber laser operating in the hybrid mode-locked regime was demonstrated. Self-starting and self-similarity of the laser output were achieved. Experiments were performed from the amplifying and frequency doubling of hybrid mode-locked laser radiation.

Poster Th-P3.4 8:30

Passively Q-switched Yb-doped fiber laser based on Ag nanoplates saturable absorber — •Pan Wang[1] and Vittorio Scardaci[2] — [1]Department of Precision Instruments, Tsinghua University, Beijing 100084, P. R. China — [2]Dipartimento di Scienze Chimiche, Università degli Studi di Catania, V.le A. Doria 6, 95125 Catania, Italy

We experimentally investigated Ag nanoplates as saturable absorber for Q-switched pulse generation in an Yb-doped fiber laser. To the best of our knowledge, it is the first demonstration of the passively Q-switched fiber laser utilizing the material of Ag nanoparticles at the wavelength of 1-μm.

Poster Th-P3.5 8:30

Geometrical phase elements based on clusters of nanoparticles and their application for generation of top-hat beams — Klemensas Laurinavičius, •Justas Berškys, Pavel Gotovski, Paulius Kizevičius, Sergej Orlov, Vytautas Jukna, and Titas Gertus — Coherent Optics Laboratory, Center for Physical Sciences and Technology, Sauletekeio ave 3, LT-10257, Vilnius, Lithuania

Construction of metasurfaces became accessible over the past years due to deposition of nanoparticles. Rapid developments of numerical methods for simulation of light interaction with metasurfaces allows for design of optical elements that act as Gauss-to-top-hat converters. We designf top-hat converters for lasing applications using engineered metaatoms

Poster Th-P3.6 8:30

Incription of efficient top-hat elements in the glass using high power femtosecond laser system — Sergej Orlov[1], Pavel Gotovski[1], Paulius Šlevas[1,2], Orestas Ulčinas[1,2], Ernestas Nacius[1,2], •Erminas Kozlovskis[1], Vytautas Jukna[1,3], and Titas Gertus[1,4] — [1]Coherent Optics Laboratory, Center for Physical Sciences and Technology, Sauletekeio ave 3, LT-10257, Vilnius, Lithuania — [2]Workshop of Photonics, Mokslininku st. 6A, LT- 08412,Vilnius, Lithuania — [3]Laser research center, Vilnius University, Sauletekio av. 10, LT- 10223, Vilnius, Lithuania — [4]Light Conversion, Keramiku st. 2B, LT-10234, Vilnius, Lithuania

We present a study on engineering efficient top-hat phase converters inscribed in the glass by femtosecond laser pulses. Moreover, we present and implement a polarization independent encoding technique, which enables a uniform energy distribution in a ring shape beam profile of a top-hat beam.

Poster Th-P3.7 8:30

Femtosecond writing of waveguides structures inside PMMA. — •Dmitrii Perevoznik[1,2], Ayhan Demircan[1,2], and Uwe Morgner[1,2,3] — [1]Institute of Quantum Optics, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover, Germany — [2]Cluster of Excellence PhoenixD (Photonics, Optics, and Engineering - Innovation AcrossDisciplines), Hannover, Germany — [3]LaserZentrum Hannover e.V., Hollerithalle 8, D-30419 Hannover, Germany

We report on the femto-second laser writing of hexagonal structural waveguides in PMMA. The writing relies on laser induced modifications that are completely surrounding a waveguide core. We found the optimal parameters to construct highly reproducible, single-mode waveguides with minimal propagation losses down to 0.6 dB/cm.

Poster Th-P3.8 8:30

Surface Plasmon Polariton neuromorphic circuit with sigmoid activation function — •Hamed Tari, Alessandro Bile, Francesca Moratti, and Eugenio Fazio — Dipartimento di Scienze di Base e Applicate per l'Ingegneria, Sapienza Università di Roma

In the last decades, the availability of large amounts of data and the necessity of processing it efficiently has led to the rapid development of machine-learning techniques. But, unlike neural tissue, traditional computing architectures physically separate the core computing functions of memory and processing, efficient, and low-energy computing to achieve.

Poster Th-P3.9 8:30

New operating regimes of dark rectangular pulses in a high finesse standing wave cavity — •Nitish Paul[1,2], Chandrapal Singh[1,2], Pradeep Kumar Gupta[1,2], Pranab Kumar Mukhopadhyay[1,2], and Kushvinder Singh Bindra[1,2] — [1]Raja Ramanna Centre for Advanced Technology, Indore-452013, India — [2]Homi Bhabha National Institute, Mumbai-400094, India

In this work we present two distinct new operating regimes of ultra long rectangular dark pulses in a simple, all fiber, high finesse standing wave cavity. Nonlinear optical loop mirror based fast saturable absorber in the cavity is implemented by nearly 50/50 coupler not used conventionally for mode-locking.

Poster Th-P3.10 8:30

Two-frequency heteronuclear soliton molecules — •Stephanie Willms[1,2], Surajit Bose[2], Uwe Morgner[1,2,3], Ihar Babushkin[1,2], Oliver Melchert[1,2,3], and Ayhan Demircan[1,2,3] — [1]Cluster of Excellence PhoenixD, Welfengarten 1, 30167, Hannover, Germany — [2]Institute of Quantum Optics, Leibniz Universität Hannover, Welfengarten 1, 30167, Hannover, Germany — [3]Hannover Centre of Optical Technologies, Nienburger Str. 17, 30167, Hannover, Germany

We demonstrate novel types of ultrashort heteronuclear soliton molecules and characterize their properties. Different generation possibilities and robustness of propagation dynamics under perturbations are investigated. We show that these states exhibit intriguing quantum mechanical analogies. Besides binding mechanisms and dipole-like radiation, yet unknown dissociation processes and trapping phenomena are observable.

Poster Th-P3.11 8:30

Polarization-domain-wall in a dual-color mode-locked fiber laser — •Ahmed Nady[1,2], Meriem Kemel [1], Georges Semaan [1], Mohamed Salhi [1], and Francois Sanchez [1] — [1]Laboratoire de Photonique d'Angers, Université d'Angers, E. A. 4464, 2 Boulevard Lavoisier, 49045 Angers, France — [2]Department of Physics, Faculty of Science, Beni-Suef University, 62511 Beni-Suef, Egypt

We present the demonstration of polarization domain-wall pulses in a dual-color fiber laser. Wavelength-resolved study as well as polarization-resolved study has been provided. The formation of domain-wall pulses is attributed to both the strong birefringence and the cross-saturation of population inversion between two lasing beams, induced by 20 m HNLF.

Poster Th-P3.12 8:30

Direct laser writing to the PbO-rich phosphate glasses modified by CoO — •Jan Smolík[1], Jiří Schwarz[1], Petr Knotek[1], Petr Kutálek[2], and Eva Černošková[2] — [1]University of Pardubice, FCHT, Department of General and Inorganic Chemistry, Pardubice, Czech Republic — [2]University of Pardubice, FCHT, Joint Laboratory of Solid State Chemistry, Pardubice, Czech Republic

This work deals with photo-induced volume changes on the surface of glassy (100-x)(55PbO-10ZnO-35P2O5)-xCoO, x = 0-3.55 mol%, employing direct laser writing technique using continuous-wave laser operating at 532 nm. The illumination results in the creation of microlenses (lower laser fluency) or microcraters (higher laser fluency).

Poster Th-P3.13 8:30

Wedged Nd:YVO_4 crystal for wavelength tuning of monolithic passively Q-switched picosecond microchip lasers — •André Marianovich[1], Stefan Spiekermann[1], Moritz Brendel[2], Peter Wessels[1], Jörg Neumann[1], Markus Weyers[2], and Dietmar Kracht[1] — [1]Laser Zentrum Hannover e.V., Laser Development Department, Hollerithallee 8, 30419 Hannover, Germany — [2]Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik, Gustav-Kirchhoff-Str. 4, 12489 Berlin, Germany

We present a monolithic integrated passively Q-switched sub-150 ps microchip laser at 1064 nm with a slightly wedged Nd:YVO_4 crystal for fine tuning of the spectral cavity mode position relative to the gain profile to optimise the output power and to increase wafer scale mass production yield.

Th-M1: Non-linear conversion in fibers and waveguides

Chaired by Jacob Mackenzie, ORC, University of Southampton, United Kingdom

Time: Thursday, 10:15–12:00 Location: virtual

Oral Th-M1.1 10:15

Fiber optical parametric chirped-pulse oscillator at 1220 nm — •Rezki Becheker[1], Mohamed Touil[1], Said Idlahcen[1], Mincheng Tang[1], Adil Haboucha[2], Benoit Barviau[1], Frédéric Grisch[1], Patrice Camy[3], Thomas Godin[1], and Ammar Hideur[1] — [1]CORIA (UMR 6614) - CNRS - Université de Rouen Normandie - INSA Rouen, Saint Etienne du Rouvray, France — [2]Photonics Bretagne, Lannion, France — [3]CIMAP, ENSICAEN-CNRS-CEA-Université Caen Normandie, Normandie Université, Caen, France

We report the first experimental demonstration of a fiber optical parametric chirped-pulse oscillator (FOPCPO). It generates highly-chirped idler pulses with energies higher than 250 nJ and numerical simulations show that energy scaling beyond the μJ level is possible.

Oral Th-M1.2 10:30

Spectro-temporal dynamics in a fiber optical parametric oscillator — •Mohamed Touil, Rezki Becheker, Thomas Godin, and Ammar Hideur — CORIA (UMR 6614) - CNRS - Université de Rouen Normandie - INSA Rouen, Saint Etienne du Rouvray, France

We investigate for the first time the dynamics of a fiber optical parametric oscillator with an original combination of statistical tools using dispersive Fourier transform. Specifically, we use a method based on mutual information analysis to strikingly reveal particular correlation patterns and dynamics both in the build-up and steady-state regimes.

Oral Th-M1.3 10:45

Optical parametric amplification in gas-filled hollow core capillary for the generation of tunable pulses in the infrared — •Olivia Zurita-Miranda[1,2], Coralie Fourcade-Dutin[2], Pierre Béjot[3], Frédéric Fauquet[2], Jean-Paul Guillet[2], Frédéric Darracq[2], Patrick Mounaix[2], Hervé Maillotte[1], and Damien Bigourd[2,1] — [1]Femto-st, Besançon, France — [2]Laboratoire IMS, Talence, France — [3]Laboratoire Interdisciplinaire Carnot de Bourgogne, Dijon, France

We present an implementation of a scheme to generate pulses tunable from the NIR to the MIR toward a high-power, base on four-wave mixing and parametric amplification in gas-filled hollow-core capillary.

Oral Th-M1.4 11:00

Joint spatial profile and frequency conversion of an LP_{07}-fiber mode towards the blue spectral region — •Robert Lindberg[1], Xiao Liu[2], Siddharth Ramachandran[2], and Valdas Pasiskevicius[1] — [1]Department of Applied Physics, Royal Institute of Technology, 10691 Stockholm, Sweden — [2]Boston University, 8 St. Mary's St., Boston, USA 02215

We present a novel approach, based on multimode four-wave mixing and simultaneous frequency and spatial profile conversion in a nonlinear crystal, to realize high energy blue laser pulses. Experimental results are presented alongside a numerical analysis that identifies the current limitations.

Oral Th-M1.5 11:15

Assembly process and sub-Doppler spectroscopy of end-capped photonic micro-cell — •Thomas Billotte[1], Matthieu Chafer[1,2], Martin Maurel[1,2], Foued Amrani[1,2], Frederic Gerome[1,2], Benoit Debord[1,2], and Fetah Benabid[1,2] — [1]GPPMM Group, Xlim Research Institute, CNRS UMR 7252, University of Limoges, 87060 Limoges, France — [2]GLOphotonics SAS, 123 avenue Albert Thomas 87060 Limoges Cedex

Patch-cord like contaminant-free acetylene photonic microcell has been developed by an alternative sealing technique based on heat-collapsing glass sleeves at the hollow-core photonic crystal fiber tips. A high stable 25% contrast and 19MHz transit-time limited linewidth sub-Doppler spectroscopic signal has been observed over 3 months through the photonic micro-cell.

Oral Th-M1.6 11:30

Generation of 60 fs pulses at 780 nm by frequency doubling of Er doped fiber laser with tunable repetition rate for TPEF imaging — •Dorota Stachowiak[1], Jakub Bogusławski[2], Aleksander Głuszek[1], Arkadiusz Hudzikowski[1], Zbigniew Łaszczych[1], Maciej Wojtkowski[2], and Grzegorz Soboń[1] — [1]Laser & Fiber Electronics Group, Wrocław University of Science and Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland — [2]International Centre for Translational Eye Research, Institute of Physical Chemistry, Polish Academy of Sciences, Kasprzaka 44/52, 01-224 Warsaw, Poland

We demonstrate a frequency-doubled Er-doped fiber laser with tunable repetition rate, for two-photon excited fluorescence imaging (TPEF). The system provides 60 fs, 1.3 nJ pulses at 780 nm, with a repetition rate range from 1.02 MHz to 11.9 MHz. The source was successfully used in TPEF microscopy of biological samples.

Oral Th-M1.7 11:45

High-Efficient PPLN Waveguide Array for Entangled Two-Photon Fluorescence Microscopy — •Josué R. León-Torres[1], Tobias B. Gäbler[1,2], Marta Gilaberte Basset[1], Fabian Steinlechner[1], and Markus Gräfe[1] — [1]Fraunhofer Institute for Applied Optics and Precision engineering IOF, Jena, Germany — [2]Friedrich Schiller University Jena, Institute of Applied Physics, Jena, Germany

Our new development of a highly efficient entangled photon-pair source based on multiplexing of MgO:LN waveguides, represents a major step towards a future-oriented design of two-photon fluorescence microscopes. Photon-pair light sources play a crucial role in the development of this field providing an ultra-high brightness and a strong time-energy correlation.

Th-A1: Mid infrared sources and characterization

Chaired by Uwe Griebner, Max Born Institute, Berlin, Germany

Time: Thursday, 13:30–15:15 Location: virtual

Invited Th-A1.1 13:30

Mid-infrared electric field sampling approaching single-photon sensitivity — •Christina Hofer[1,2], Daniel Gerz[1,2], Maximilian Högner[1], Thomas P. Butler[3], Christian Gaida[4], Tobias Heuermann[5,6], Martin Gebhardt[5,6], Nicholas Karpowicz[7], Jens Limpert[5,6,8], Ferenc Krausz[1,2], and Ioachim Pupeza[1,2] — [1]Max Planck Institute of Quantum Optics, Garching, Germany — [2]Ludwig Maximilians University Munich, Faculty of Physics, Garching, Germany — [3]University of Maryland, Institute for Research in Electronics and Applied Physics, College Park MD, United States — [4]Active Fiber Systems GmbH, Jena, Germany — [5]Institute of Applied Physics, Abbe Centre of Photonics, Friedrich-Schiller Universität Jena, Jena, Germany — [6]Helmholtz-Institute Jena, Jena, Germany — [7]CNR NANOTEC Institute of Nanotechnology, Lecce, Italy — [8]Fraunhofer Institute for Applied Optics and Precision Engineering, Jena, Germany

We present a Thulium-fiber-laser-based, field-resolved spectrometer, optimized for mid-infrared photon detection efficiency. With this system, we measure few-cycle mid-infrared fields with nearly single-photon sensitivity via electro-optic sampling. This pushes field-resolved spectroscopy to its fundamental limits and paves the way for linear detection of mid-infrared intensities over 18 orders of magnitude.

Oral Th-A1.2 14:00

Mid-infrared waveform measurement by rapid mechanical scanning — •Philip Jacob[1], Alexander Weigel[1,2], David Gröters[2], Theresa Buberl[1], Michael Trubetskov[1], Marinus Huber[1,2], Joachim Heberle[3], and Ioachim Pupeza[1,2] — [1]Max-Planck-Institut für Quantenoptik, Garching, Germany — [2]Ludwig Maximilians Universität München, Garching, Germany — [3]Freie Universität Berlin, Berlin, Germany

We report field-resolved detection of few-cycle mid-infrared waveforms by electro-optic sampling, with rapid mechanical delay scanning at 38 kHz using a sonotrode. An interferometric delay calibration signal is recorded simultaneously to achieve a timing precision of 15 attoseconds between electric field traces on averaging 100 scans.

Oral Th-A1.3 14:15

Narrowband Difference-frequency Generation at 4.6 – 10.8 μm in $LiGaS_2$ and $LiGaSe_2$ Pumped by 20-picosecond Nd:YAG Laser and Raman Laser Seeding — •Michal Jelinek[1], Vaclav Kubecek[1], Miroslav Cech[1], Sergei Smetanin[2], Alexsey Kurus'[3,4], Sergei Lobanov[3,4], Vitaliy Vedenyapin [3,4], and Lyudmila Isaenko [3,4] — [1]Czech Technical University in Prague — [2]Prokhorov General Physics Institute, Russian Academy of Sciences — [3]Sobolev Institute of Geology and Mineralogy, Siberian Branch Russian Academy of Sciences — [4]Novosibirsk State University

50-μJ-level narrowband difference-frequency generation at discrete wavelengths from 4.6 up to 10.8 μm in high-damage-threshold $LiGaS_2$ and $LiGaSe_2$ crystals under 20-ps Nd:YAG laser pumping and various crystalline ($CaCO_3$, $BaWO_4$, diamond) Raman laser seeding is presented.

Oral Th-A1.4 14:30

Fabrication of a quasi-phase-matching stack of multiple GaAs plates with lower scattering loss at the bonded interfaces by use of room-temperature bonding — •Rika Tanimoto, Yuki Takahashi, and Ichiro Shoji — Chuo University, Tokyo, Japan

A quasi-phase-matching stack of 10 GaAs plates with better surface flatness and increased transmittance has been successfully fabricated using the room-temperature-bonding technique, which is for high-power wavelength-conversion device in mid-infrared region. This was accomplished by setting GaAs plates on YAG crystals with flat surfaces of laser grade.

Oral Th-A1.5 14:45

Trade-offs in maximum-phonon-energy and thermal conductivity for mid-infrared laser materials — •Zackery Fleischman, Ei Ei Brown, Victoria Blair, and Mark Dubinskii — US Army Research Laboratory, ATTN FCDD-RLS-RL, 2800 Powder Mill Road, Adelphi, MD 20783, USA

We characterized a number of novel gain materials for potential use in mid-infrared lasers, focusing on cataloguing their thermal and vibrational properties. The trade-off between these parameters is highlighted, and a new dual-phase nanocomposite was developed to achieve optimum material performance.

Oral Th-A1.6 15:00

Comparative study of rare-earth (Dy3+, Ho3+, Er3+) doped barium fluoride single crystals for diode-pumped ~3.0 um laser development — •Ei Ei Brown[1], Zackery Fleischman[1], Jenny Rosen[2], William Haller[3], Jason McKay[1], and Mark Dubinskii[1] — [1]US Army Research Laboratory, Adelphi, MD, USA — [2]Department of Materials Science & Engineering, Cornell University, Ithaca, NY 14853, USA — [3]Department of Materials Science & Engineering, University of Maryland, College Park, MD 20742, USA

We carried out a comprehensive comparative spectroscopic study of Dy3+, Ho3+, and Er3+ ions in BaF2 single crystals. We present spectroscopic results to include Judd-Ofelt-analysis, transition cross-sections, and decay kinetics of each ion in the BaF2 host, and interpret them from the standpoint of optimization for ~3.0 um laser development.

Th-A2: Solitons I, supercontinuum and Raman processes in fibers

Chaired by Jonathan Bradley, MCMaster University, Hamilton, Ontario, Canada

Time: Thursday, 15:30–17:15 Location: virtual

Invited Th-A2.1 15:30

Time-Locked Multi-Color Single-Aperture Fiber Sources via Soliton Self-Mode Conversion — •Havva Begüm Kabagöz, Aku Antikainen, and Siddharth Ramachandran — Boston University, Boston, USA

Group-velocity matching across spatial modes of multimode fibers yields dual-, triple-, or even quadruple-color energetic ultrashort pulses that are naturally temporally locked and emit from a single fiber aperture. The underlying mechanism is the recently discovered soliton self-mode conversion process that governs soliton dynamics in multimode fibers.

Oral Th-A2.2 16:00

Demonstration of supercontinuum and frequency shifted solitons pumped at 1.56 μm as seed sources for Tm-doped fiber amplifiers — •Olga Szewczyk[1], Aleksander Głuszek[1], Tadeusz Martynkien[2], Karol Tarnowski[2], Paweł Mergo[3], and Grzegorz Soboń[1] — [1]Laser & Fiber Electronics Group, Wrocław University of Science and Technology, 50-370 Wrocław, Poland — [2]Department of Optics and Photonics, Wrocław University of Science and Technology, 50-370 Wroclaw, Poland — [3]Laboratory of Optical Fiber Technology, Maria Curie-Skłodowska University, 20-031 Lublin, Poland

We present a direct comparison of all-normal dispersion supercontinuum and frequency shifted solitons as seed pulses for a Tm-doped fiber amplifier. Our study included measurement of shot-to-shot stability, degree of coherence, intensity noise and pulse spectral phase. We show that solitons are excellent seed pulses for amplification, outperforming the supercontinuum.

Oral Th-A2.3 16:15

Observation of supercontinuum spiral emission in optical fibers — •Fabio Mangini[1], Mario Ferraro[2], Mario Zitelli[2], Alioune Niang[1], Alessandro Tonello[3], Vincent Couderc[3], and Stefan Wabnitz[2] — [1]Department of Information Engineering (DII), University of Brescia, Via Branze 38, 25123 Brescia, Italy — [2]Department of Information Engineering, Electronics and Telecommunications (DIET), Sapienza University of Rome, Via Eudossiana 18, 00184 Rome, Italy — [3]Université de Limoges, XLIM, UMR CNRS 7252, 123 Avenue A. Thomas, 87060 Limoges, France

We report the observation of supercontinuum spiral emission when a femto-second laser beam with tens megawatt peak power is coupled with multimode fibers. The far-field spectral components are spatially separated following the spiral shape, while in the near field the light fully belongs fully to the cladding.

Oral Th-A2.4 16:30

Polarization-dependent relative intensity noise of fiber supercontinuum sources — •Dirk-Mathys Spangenberg, Benoît Sierro, and Alexander M. Heidt — Institute of Applied Physics, University of Bern, Sidlerstrasse 5, 3012 Bern, Switzerland

Detailed experimental polarization-dependent relative intensity noise (RIN) measurements of all-normal dispersion (ANDi) and conventional supercontinuum (SC) sources are presented. We show that the polarization-maintaining ANDi fiber suppresses polarization noise, is robust against pump polarization fluctuations, and allows ultra-low noise SC generation with RIN identical to the pump laser (< 0.05%).

Oral Th-A2.5 16:45

Dependence of Raman scattering on the orbital angular momentum of light — •Xiao Liu, Aku Antikainen, and Siddharth Ramachandran — Boston University, Boston, USA

We demonstrate that the inherent chirality of orbital angular momentum (OAM) modes in fibers can be used for controlling Raman gain. With Raman suppression up to 15 dB and mode-dependent control, this suggests a new design methodology for tailoring the Raman response in fibers.

Oral Th-A2.6 17:00

Pump conversion and beam clean up at cascaded random Raman lasing in multimode graded-index fibers — Alexey G. Kuznetsov[1], Sergey I. Kablukov[1,2], Ekaterina A. Evmenova[1], Alexey A. Wolf[1,2], Evgeniy V. Podivilov[1,2], Stefan Wabnitz[2,3], and •Sergey A. Babin[1,2] — [1]Institute of Automation and Electrometry SB RAS, Novosibirsk, Russia — [2]Novosibirsk State University, Novosibirsk, Russia — [3]Sapienza University of Rome, Rome, Italy

We measure pump and Stokes beam profiles near and above the Raman threshold in LD-pumped 100-μm GRIN-fiber Raman laser with FBG/random cavities. Analytical model is developed describing Raman gain, pump and Stokes beam profiles. The role of different linear and nonlinear effects in the output beam shaping is discussed.

Th-A3: Optical Parametric Oscillators

Chaired by Andrejus Michailovas, EKSPLA, Vilnius, Lithuania

Time: Thursday, 17:30–19:15 Location: virtual

Oral Th-A3.1 17:30

Temporally resolved studies of thermal effects in high power ZGP OPO pumped by high-repetition Ho:LLF MOPA system — •Marcin Piotrowski[1], Manuel-Alessandro Medina[1,2], Martin Schellhorn[1], and Anne Hildenbrand-Dhollande[1] — [1]French-German Research Institute of Saint-Louis (ISL), 5 rue du Général Cassagnou, 68301 Saint-Louis, France — [2]Aix Marseille Univ., CNRS, Centrale Marseille, Institut Fresnel, Marseille, France

We provide experimental insight to evolution of thermal effects in non-linear optical crystals. We evaluate methods for a beam quality improvement for mid-IR ZGP OPOs using linear and non-planar ring cavities of different geometries and lengths. We also study the effect of the pump repetition rate on a beam quality.

Oral Th-A3.2 17:45

Kerr-lens mode locked, synchronously pumped, ultrabroadband breathing pulse optical parametric oscillator — •Jintao Fan[1,2], David Zuber[1,2], Robin Mevert[1,2], Tino Lang[3], Thomas Binhammer[4], and Uwe Morgner[1,2,5] — [1]Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover, Germany — [2]Cluster of Excellence PhoenixD (Photonics, Optics, and Engineering-Innovation Across Disciplines), 30167, Hannover, Germany — [3]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany — [4]neoLASE GmbH, Hollerithallee 17, 30419 Hannover, Germany — [5]Laser Zentrum Hannover e.V., Hollerithallee 8, 30419 Hannover, Germany

We demonstrate a Kerr-lens mode locked non-collinear optical parametric oscillator (KLM-NOPO). Pumped by a 270 fs frequency doubled Yb-fiber laser, an ultrabroadband signal spanning from 700 nm to 900 nm at the -10 dB level is obtained, which would support sub-10 fs pulse durations.

Oral Th-A3.3 18:00

Degenerate Backward wave Optical Parametric Oscillator — •Patrick Mutter[1], Andrius Zukauskas [1], Anne-Lise Viotti[2,3], Valdas Pasiskevicius[1], and Carlota Canalias[1] — [1]Royal Institute of Technology, Stockholm, Sweden — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [3]Lund University, Lund, Sweden

We present the first backward wave optical parametric oscillator operating at degeneracy with conversion efficiency exceeding 53%. The BWOPO is realized using a 1mm thick PPKKTP crystal with a period of 435 nm, and generates counter-propagating signal and idler in the spectral band of optical communications.

Oral Th-A3.4 18:15

Non-collinear Optical Parameric Oscillator as fast tuneable light source for Stimulated Raman Scattering — •Luise Beichert[1,2], Yuliya Binhammer[1,2], José Ricardo Andrade[1,2], and Uwe Morgner[1,2] — [1]Institut für Quantenoptik, Leibniz Uni Hannover, Hannover, Germany — [2]Cluster of Excellence PhoenixD (Photonics, Optics and Engineering - Innovation Across Disciplines), Hannover, Germany

We present a Non-collinear Optical Parametric Oscillator (NOPO) for Stimulated Raman Spectroscopy. The NOPO is fastly tuneable between 650 and 1030 nm in a few microseconds and delivers up to 1 W output power. We show the detection of microplastics particles in water solution at a speed of 65 Hz.

Oral Th-A3.5 18:30

Compact picosecond mid-IR PPLN OPO in burst-mode operation — •Yudi Wu, Sijing Liang, Qiang Fu, Lin Xu, and David J. Richardson — Optoelectronics Research Centre, University of Southampton, Southampton, UK

A compact, mid-infrared, synchronously-pumped optical parametric oscillator (OPO) based on periodically poled lithium niobate (PPLN) is developed. In burst-mode operation, the OPO generates picosecond pulses at 1.5-GHz repetition rate, with wavelength tunability of 2-3.5 μm and controllable peak powers up to a maximum of 1.2 kW.

Oral Th-A3.6 18:45

Influence of higher order dispersion on a half-harmonic generator — •Christian Markus Dietrich[1,2], Ihar Babushkin[1,2], José Ricardo Cardoso de Andrade[1,2], Han Rao[1,2], Ayhan Demircan[1,2], and Uwe Morgner[1,2] — [1]Institute of Quantum Optics, Leibniz University Hannover, Welfengarten 1, 30167 Hannover, Germany — [2]Institute of Quantum Optics, Leibniz University Hannover, Welfengarten 1, 30167 Hannover, Germany

We discuss the influence of higher order dispersion on a doubly resonant optical parametric oscillator (DROPO). We show how the complex interplay of the phase- and group-delay detunings for different frequencies forms the global picture of the emission of the DROPO, and suggest the ways to improve the self-locking range.

Oral Th-A3.7 19:00

38 W high repetition rate ZGP OPO and novel approaches to improve beam quality in miniaturized non-planar cavities — •Manuel Alessandro Medina[1,2], Marcin Piotrowski[1], Martin Schellhorn[1], Frank Wagner[2], Antoine Berrou[1], and Anne Hildenbrand-Dhollande[1] — [1]French-German Research Institute of Saint-Louis (ISL), 5 rue du Général Cassagnou, 68301 Saint-Louis Cedex, France — [2]Aix-Marseille Univ., CNRS, Centrale Marseille, Institut Fresnel, Marseille, France

We present high average power mid-IR ZGP OPO at high repetition. 38 W at 10 kHz were obtained in a linear OPO cavity with a beam quality M^2 of 2.2. We also investigate beam quality improvement using compact, non-planar OPO cavities fabricated by post-processed 3-D printing.

Th-IND: Industrial session

Time: Thursday, 19:30–20:15 Location: virtual

Industrial talk Th-IND.1 19:30

Overview of company EKSPLA and products offered — •Giedrius Kudaba — EKSPLA, Vilnius, Lithuania

EKSPLA was established in the year 1992. Since then, EKSPLA had delivered a wide range of lasers and laser set-ups for science and industry. The company's products are successfully installed for many applications, some of them are specially tailored. One of the examples is the NL740 laser for LIDT application.

Industrial talk Th-IND.2 19:45

Recent advancements in OPCPA front-end design and manufacturing — •Valdas Maslinkas — Light Conversion, Keramiku st. 2B, LT-10233, Vilnius, Lithuania

OPCPA is state-of-the-art technique for producing powerful ultrashort light pulses for advanced scientific applications. We present user-tailored front-end setups that exploits reliability, compactness and stability of the mature femtosecond DPSS laser system (PHAROS), to produce broadband multi-μJ pulses ideal for seeding OPCPA or independently driving multiple spectroscopic application.

Industrial talk Th-IND.3 20:00

Overview on iXblue Photonics and focus on ModBox-FrontEnd Solution — •Hervé Gouraud — iXblue-Photonics, Besançon, France

iXblue photonics is a global high-tech company specializing in the design and manufacturing of advanced photonics technologies. We produce LiNbO3 modulators and their matching components, turn-key and ease to use modulation solutions, fibres, FBGs... Our solutions are dedicated to laser, from oscillator to high power, and from ground to space.

Fr-M1: Solitons II, fiber fabrication and design

Chaired by Matthias Jäger, Leibniz Institute of Photonic Technologies, Jena, Germany

Time: Friday, 8:45–10:15 Location: virtual

Invited Fr-M1.1 8:45

Polychromatic soliton molecules from a fiber laser — •Joshua P. Lourdesamy[1], Antoine F. J. Runge[1], Tristram J. Alexander[1], Darren D. Hudson[2], Andrea Blanco-Redondo[3], and C. Martijn de Sterke[1,4] — [1]Institute of Photonics and Optical Science (IPOS), School of Physics, The University of Sydney, NSW 2006, Australia — [2]CACI Photonics Solutions, 15 Vreeland Road, Florham Park, NJ 07932, USA — [3]Nokia Bell Labs, 791 Holmdel Road, Holmdel, NJ 07733, USA — [4]The University of Sydney Nano Institute (Sydney Nano), The University of Sydney, NSW 2006, Australia

We experimentally confirm the existence of soliton molecules formed by a bound state of two fundamental solitons centered at different frequencies, but with identical group velocities, inside a mode-locked laser with a spectral pulse-shaper to achieve the desired dispersion. The frequency difference leads to temporal beating and to pulse narrowing.

Oral Fr-M1.2 9:15

High-energy spatiotemporal solitons in GRIN fiber — •Fabio Mangini[1], Mario Zitelli[2], Mario Ferraro[2], Denis Sergeevich Kharenko[3], Alioune Niang[1], Alessandro Tonello[4], Vincent Couderc[4], and Stefan Wabnitz[2,3] — [1]Department of Information Engineering (DII), University of Brescia, Via Branze 38, 25123 Brescia, Italy — [2]Department of Information Engineering, Electronics and Telecommunications (DIET), Sapienza University of Rome, Via Eudossiana 18, 00184 Rome, Italy — [3]Novosibirsk State University, Pirogova 1, Novosibirsk 630090, Russia — [4]Université de Limoges, XLIM, UMR CNRS 7252, 123 Avenue A. Thomas, 87060 Limoges, France

The soliton fission dynamics in the high-energy regime is experimentally and numerically investigated in graded-index multimode fiber. It has been observed that the solitons generated by the fission exhibit the same time duration and halt their Raman self-frequency shift. These dynamics are analyzed by comparing experimental measurements and numerical simulations

Oral Fr-M1.3 9:30

Pump Combiner with Chirally Coupled Core Fibers for Side Pumped Single Frequency All Fiber Amplifiers — •Eike Brockmüller[1], Sven Hochheim[1], Peter Wessels[1], Joona Koponen[2], Tyson Lowder[3], Steffen Novotny[2], Jörg Neumann[1], and Dietmar Kracht[1] — [1]Laser Zentrum Hannover e.V. Laser Development Department, Hannover, Germany — [2]nLight Oy, Lohja, Finland — [3]nLIGHT Inc., Vancouver, USA

We developed an all-fiber power combiner with an integrated Chirally Coupled Core feed-through fiber in a side pumping technique with an uninterrupted signal core. For the first time, this component enables all-fiber systems with Chirally Coupled Core fibers and can be implemented in almost any fiber laser or amplifier architecture.

Oral Fr-M1.4 9:45

CO_2-laser based manufacturing of a few-mode all-fiber evanescent field coupler — •Felix Wellmann[1], Michael Steinke[1], Peter Wessels[1], Ludger Overmeyer[1,2], Jörg Neumann[1], and Dietmar Kracht[1] — [1]Laser Zentrum Hannover e.V., Hollerithallee 8, 30419 Hannover, Germany — [2]Institut für Transport- und Automatisierungstechnik, Leibniz Universität Hannover, An der Universität 2, 30823 Garbsen, Germany

We present a CO_2-laser based micro-machining process to manufacture all-fiber mode-selective couplers. Large parts of the fiber's glass cladding are laterally removed to access the core's evanescent field. Excellent surface quality is demonstrated. Low loss (0.13 dB) coupling between fiber cores was achieved by fusing two altered fibers together.

Oral Fr-M1.5 10:00

3D printed Er-doped silica fibre by Direct Ink Writing — •Angeles L. Camacho-Rosales, Martín Núñez-Velázquez, and Jayanta Sahu — University of Southampton, Southampton, UK

We present a 3D printed Er-doped silica optical fibre produced by direct ink writing (DIW) method. The optical characterisation of the multimode, 50/100 μm (core/clad), Er-doped fibre is reported.

Fr-M2: Pulse compression

Chaired by Antoniangelo Agnesi, Università di Pavia, Italy

Time: Friday, 10:30–12:15 Location: virtual

Oral Fr-M2.1 10:30

Sub-3-cycle radially polarized pulses from post-compression in multiple thin plates — Huabao Cao[2], •Roland Sandor Nagymihaly[1], Nikita Khodakovskiy[1], Rodrigo Lopez-Martens[3], Viktor Pajer[1], Janos Bohus[1], Benoit Bussiere[4], Franck Falcoz[4], Adam Borzsonyi[1], and Mikhail Kalashnikov[1] — [1]ELI-ALPS, ELI-Hu Nonprofit Ltd., Wolfgang Sandner utca 3, 6728 Szeged, Hungary — [2]Xi'an Institute of Optics and Precision Mechanics of CAS, Xi'an 710119, China — [3]Laboratoire d'Optique Appliquée, CNRS, Ecole Polytechnique, ENSTA Paris, Institut Polytechnique de Paris, 181 chemin de la Hunire et des Joncherettes 91120 Palaiseau, France — [4]Amplitude Technologies, 2-4 rue du Bois Chaland, CE 2926 91029 Evry, France

Post-compression of radially polarized 30 fs pulses was performed in multiple thin fused silica plates for the first time. Sub-7 fs pulses with 90 μJ at 100 Hz repetition rate were obtained after re-compression by chirped mirrors. This approach is scalable in pulse energy.

Oral Fr-M2.2 10:45

A pulse compression scheme and its application to spin emitter characterization — •Anne-Laure Calendron[1,2,3], Joachim Meier[4], Elias Kueny[1,2], Sven Velten[1], Lars Bocklage[1,3], Ralf Röhlsberger[1,3,5], and Franz X. Kärtner[1,2,3] — [1]Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany — [2]Center for Free-Electron Laser Science (CFEL), Hamburg, Germany — [3]The Hamburg Centre for Ultrafast Imaging, Hamburg, Germany — [4]The European X-FEL, Schenefeld, Germany — [5]Helmholtz-Institut Jena, Jena, Germany

The 35-fs long pulses of a commercial Ti:Sapphire amplifier are compressed nonlinearly to ~20 fs and used for electro-optical sampling of terahertz waveforms generated by spin emitters.

Oral Fr-M2.3 11:00

Hybridizing Multi-pass and Multi-plate Bulk Compression — •Marcus Seidel[1], Prannay Balla[1], Thomas Binhammer[2], Maik Frede[2], Gunnar Arisholm[3], Lutz Winkelmann[1], Ingmar Hartl[1], and Christoph M. Heyl[1,4] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany — [2]neoLASE, Hollerithallee 17, 30419 Hannover, Germany — [3]FFI (Norwegian Defence Research Establishment), P. O. Box 25, NO-2027 Kjeller, Norway — [4]Helmholtz-Institute Jena, Fröbelstieg 3, 07743 Jena, Germany

We introduce the combination of multi-pass cell and multi-plate spectral broadening schemes. Experimentally, we demonstrate the compression of 100-μJ pulses from 880-fs to 65-fs in a single stage. Moreover, we simulate compression to 40-fs by means of nonlinear mode-matching. This doubles the single-stage compression factors achieved from bulk broadening so-far.

Oral Fr-M2.4 11:15

75 fs, 1 MHz, 80 μJ burst-mode pump probe laser for the FLASH soft-X-ray FEL facility utilizing nonlinear compression of an Yb-amplifier chain. — O. Akcaalan[1], P. Balla[1,3], T. Binhammer[2], J. Darvill[1], M. Frede[2], U. Grosse-Wortmann[1], I. Hartl[1], C. M. Heyl[1,3], C. Li[1], •B. Manschwetus[1], C. Mohr[1], J. Müller[1], F. Pressacco[1], O. Puncken[2], N. Schirmel[1], M. Seidel[1], A. Swiderski[1], H. Tavakol[1], C. Vidoli[1], and L. Winkelmann[1] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany — [2]neoLASE GmbH, Hollerithallee 17, 30419 Hannover, Germany — [3]Helmholtz-Institute Jena, Fröbelstieg 3, 07743 Jena, Germany

We generate a 1 MHz train of 75 fs, 80 μJ, pulses during 800 μs bursts at 10 Hz burst repetition frequency from a spectrally broadened Yb:fiber / Yb:YAG amplifier chain for pump-probe experiments at the FLASH soft-X-ray Free Electron Laser Facility

Oral Fr-M2.5 11:30

Post-compression of high average power picosecond pulses for few cycle generation and FEL pump-probe experiments — •Anne-Lise Viotti[1,2], Skirmantas Alisauskas[1], Prannay Balla[1,3], Ammar Bin Wahid[1], Ivan Sytcevich[2], Chen Guo[2], Laura Silletti[1], Andrea Cartella[4], Hamed Tavakol[1], Uwe Grosse-Wortmann[1], Arthur Schönberg[1,3], Marcus Seidel[1], Bastian Manschwetus[1], Tino Lang[1], Andrea Trabattoni[1], Francesca Calegari[1,4,5], Arnaud Couairon[6], Anne L'Huillier[2], Cord L. Arnold[2], Ingmar Hartl[1], and Christoph M. Heyl[1,3] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany — [2]Department of Physics, Lund University, P.O Box 118, SE-221 00 Lund, Sweden — [3]Helmholtz-Institute Jena, Fröbelstieg 3, 07743 Jena, Germany — [4]The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, 149 Luruper Chaussee, Hamburg 22761, Germany — [5]Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [6]Centre de Physique Théorique, CNRS, Ecole Polytechnique, Institut Polytechnique de Paris, F-91128 Palaiseau, France

We demonstrate post-compression of 1.2 ps pulses to the few-cycle regime via multi-pass spectral broadening. We achieve compression factors of 40 via single and >90 via dual stage compression employing mJ pulses. Long term stability measurements show that such post-compression setup can be employed for FEL pump-probe experiments.

Oral Fr-M2.6 11:45

Nonlinear spectral compression in a multipass cell — •Nour Daher[1], Florent Guichard[2], Xavier Délen[1], Yoann Zaouter[2], Marc Hanna[1], and Patrick Georges[1] — [1]Université Paris-Saclay, Institut d'Optique Graduate School, CNRS, Laboratoire Charles Fabry, 91127, Palaiseau, France — [2]Amplitude Laser, 11 Avenue de Canteranne, Cité de la Photonique, 33600 Pessac, France

We demonstrate the generation of near Fourier transform-limited high peak power picosecond pulses through spectral compression in a nonlinear solid-state-based multipass cell. Input 260 fs pulses negatively chirped to 2.4 ps are spectrally compressed from 6 nm down to 1.1 nm, at 13.5 μJ output energy.

Oral Fr-M2.7 12:00

Overcoming gas ionization limits with divided-pulse nonlinear compression. — •Gregory W Jenkins, Chengyong Feng, and Jake Bromage — University of Rochester, Rochester, USA

We simulate Kerr and plasma nonlinearities in a hollow-core fiber to show how plasma effects degrade energy throughput and pulse compression. By dividing a high-energy pulse into multiple low-energy pulses, spectrally broadening low-energy pulses, and recombining back into one high-energy pulse, simulations predict the plasma effects can be avoided entirely.

Fr-A1: Fiber lasers: transverse mode stability and special wavelengths

Chaired by Grzegorz Sobon, Wroclaw University, Wroclaw, Poland

Time: Friday, 13:30–15:15 Location: virtual

Oral Fr-A1.1 13:30

Transverse mode instability in fiber-laser systems driven by intensity noise — •Sobhy E. Kholaif[1], Christoph Stihler[1,3], Cesar Jauregui[1], Yiming Tu[1], and Jens Limpert[1,2,3] — [1]Institute of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Albert-Einstein-Str. 15, 07745 Jena, Germany — [2]Helmholtz-Institute Jena, Fröbelstieg 3, 07743 Jena, Germany — [3]Fraunhofer Institute for Applied Optics and Precision Engineering, Albert-Einstein-Str. 7, 07745 Jena, Germany

In this work we reveal that pump intensity-noise acts as the main driving force for transverse mode instability (TMI) in saturated fiber amplifiers, whereby seed intensity-noise can also impact the TMI threshold. An in-depth understanding of the findings will be presented together with guidelines for developing high-power diffraction-limited fiber laser-systems.

Oral Fr-A1.2 13:45

Mitigation of transverse mode instability in high-power fiber amplifiers using traveling waves — •Yiming Tu[1], Cesar Jauregui[1], Christoph Stihler[1,3], Sohby E. Kholaif[1], and Jens Limpert[1,2,3] — [1]Institute of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Jena, Germany — [2]Helmholtz-Institute Jena, Jena, Germany — [3]Fraunhofer Institute for Applied Optics and Precision Engineering, Jena, Germany

A novel method to mitigate transverse mode instability (TMI) in high-power fiber amplifiers is proposed. This technique induces traveling waves to control the phase shift in the fiber. Thus, the approach can achieve a pure fundamental mode output twice above the TMI threshold regardless of the excitation conditions.

Oral Fr-A1.3 14:00

Correlation of mode instabilities in forward and backward direction — •Friedrich Möller[1], Victor Distler[1,2], Maximilian Strecker[1], Till Walbaum[1], Thomas Schreiber[1], and Andreas Tünnermann[1,2] — [1]Fraunhofer Institute for Applied Optics and Precision Engineering, Albert-Einstein-Str. 7, 07745 Jena, Germany — [2]Institute of Applied Physics, Friedrich-Schiller-Universität Jena, Albert-Einstein-Str. 15, 07745 Jena, Germany

Experiments with a monolithic Ytterbium-doped 20/400 μm fiber amplifier reveal a strong temporal correlation of forward and backward propagating light once the TMI-threshold is reached. Our measurements indicate that the refractive index grating induced by mode interference significantly influences the backward propagating light and enable TMI detection within the preamplifier.

Oral Fr-A1.4 14:15

150-W continuous wave laser emission at 2.09 μm from a Tm3+, Ho3+-codoped single-oscillator monolithic fiber laser — •Arnaud Motard[1,2], Nicolas Dalloz[1], Christophe Louot[1], Thierry Robin[3], Benoit Cadier[3], Inka Manek-Hönninger[2], and Anne Hildenbrand-Dhollande[1] — [1]French-german research Institute of Saint-Louis, 68300 SAINT-LOUIS, France — [2]Université Bordeaux, CNRS CEA, CELIA UMR5107, 33405 Talence, France — [3]IXBLUE PHOTONICS, 22300 Lannion, France

A bi-directionally 793-nm diode-pumped Tm3+, Ho3+-codoped silica PM double-clad fiber laser based on a single-oscillator architecture is reported, providing output power of up to 153 W at 2.09 μm. In order to improve the output beam quality, a complete analysis of the intracavity laser beam is presented.

Oral Fr-A1.5 14:30

Pulsed Single-Frequency Polarization-Maintaining Holmium Laser at 2050 & 2090 nm — •Dominik Lorenz[1,2], Clément Romano[1], Christelle Kieleck[1], and Marc Eichhorn[1,2] — [1]Fraunhofer IOSB (Institute of Optronics, System Technologies and Image Exploitation), Gutleuthausstraße 1, 76275 Ettlingen, Germany — [2]Karlsruhe Institute of Technology, Institute of Control Systems (IRS), Fritz-Haber-Weg 1, 76131 Karlsruhe, Germany

We report on the development of a nanosecond pulsed laser based on external modulation and polarization-maintaining Holmium amplifiers operating at 2050 & 2090 nm. We demonstrate peak power greater than 120 W at 10 kHz repetition rate for a pulse width of 30 ns.

Oral Fr-A1.6 14:45

Upconversion-assisted Er-doped fluoride fibre laser at 2.8 um directly diode-pumped at ~1.5 um — Radha Pattnaik, Viktor Fromzel, Jun Zhang, and •Mark Dubinskii — Army Research Laboratory, 2800 Powder Mill Road, Adelphi, Maryland 20783, USA

We report what is believed to be the first demonstration of efficient upconversion-assisted Er-doped fibre laser at 2.8 um, diode-pumped at ~1.5 um directly into a terminal laser level. We achieved 2.3 W of CW power from Er-doped ZBLAN fibre with the slope efficiency of 13% versus absorbed pump power.

Oral Fr-A1.7 15:00

Stable operation of a high-power Tm3+:ZBLAN fiber MOPA at 813 nm — •Yuichi Takeuchi[1], Eiji Kajikawa[1,2], Tomohiro Ishii[1], Kazuhiko Ogawa[2], and Mitsuru Musha[1] — [1]Institute for Laser science,Univ. of Electro-communications, Tokyo, Japan — [2]FiberLabs Inc, KDDI Resarch building, Saitama,Japan

We have developed the stable and high power fluoride glass fiber MOPA system with cascade configuration at 813 nm for the Sr optical lattice clock. The output power of more than 1.5 W is obtained with SNR of more than 50 dB.

Fr-A2: Oscillators and combs

Chaired by Clara Saraceno, Ruhr-University, Bochum, Germany

Time: Friday, 15:30–17:00 Location: virtual

Oral Fr-A2.1 15:30

Interferometric stabilization of a difference-frequency conversion set-up for CEP stable Mid IR frequency comb generation — •Dominic Laumer[1,2], Guang Yang[2,3], Vinicius Silva De Oliveira[1,8], Yuxuan Ma[1], Andrey Yachmenev[2,3], Axel Ruehl[1,4,5], Piotr Masłowski[6], Jochen Küpper[2,3], Christoph M. Heyl[1,7], and Ingmar Hartl[1] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]Department of Physics and Centre for Ultrafast Imaging, Universität Hamburg, Hamburg, Germany — [3]Center for Free-Electron Laser Science, Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [4]Leibniz University Hannover, QUEST-Leibniz-Research School, Institute for Quantum Optics, Hannover, Germany — [5]Laser Zentrum Hannover e.V, Hannover, Germany — [6]Institute of Physics, Faculty of Physics, Astronomy and Informatics, Nicolaus Copernicus University in Toruń, Toruń, Poland — [7]Helmholtz-Institute Jena, Jena, Germany — [8]Currently at Department of Physics, Umeå University, Umeå, Sweden

We report interferometric pump/signal delay stabilization of a DFG based MIR frequency comb, with OPD fluctuations recorded as low as 9 nm between pump and signal. This solution provides us with a low-noise and CEP-stable MIR light source usable for high-sensitivity, high-resolution absorption spectroscopy.

Oral Fr-A2.2 15:45

Exploiting $\chi^{(2)}$: ultra-broadband combs and few-cycle pulses from an erbium fiber laser — •Daniel Lesko, Henry Timmers, Sida Xing, Abijith Kowligy, Alexander Lind, and Scott Diddams — Time and Frequency, National Institute of Standards and Technology

Erbium fiber combs have been proven as indispensable tools for spectroscopy, microscopy, and metrology. Their peak powers are limited by gain and fiber nonlinearity. We show a scalable approach to generate near-single cycle combs and exploit $\chi^{(2)}$ nonlinear optics to generate ultra-short CEP stable infrared pulses and multi-octave combs.

Oral Fr-A2.3 16:00

Passively mode-locked cryogenic Yb:YLF laser with 28 W average power — •Umit Demirbas[1,2], Jelto Thesinga[1], Huseyin Cankaya[1,3], Martin Kellert[1], Franz X. Kärtner[1,3], and Mikhail Pergament[1] — [1]Center for Free-Electron Laser Science, Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany — [2]Laser Technology Laboratory, Antalya Bilim University, 07190 Dosemealti, Antalya, Turkey — [3]Physics Department, University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

We report a saturable Bragg reflector (SBR) mode-locked cryogenic Yb:YLF laser producing 4.3 ps long pulses at 28 W average power and 600 nJ energy at 46.45 MHz repetition rate. The central wavelength of the pulses was tunable in the 1013.5-1019 nm range using an intracavity birefringent filter.

Oral Fr-A2.4 16:15

Femtosecond dual-comb Yb:CaF_2 laser from a free-running polarization-multiplexed cavity for rapid optical sampling — •Benjamin Willenberg, Justinas Pupeikis, Léonard M. Krüger, Florian Koch, Christopher R. Phillips, and Ursula Keller — Department of Physics, Institute for Quantum Electronics, ETH Zurich, Switzerland

We demonstrate a common-cavity polarization-multiplexed dual-comb Yb:CaF_2 oscillator. Each comb of the laser delivers simultaneously 440-mW average power with 175-fs and 3.2-nJ pulses at 137-MHz repetition-rate and stable repetition-rate difference of 1-kHz. We thereby demonstrate rapid low-noise ASOPS on SESAM and VECSEL structures probing dynamics on the fs-to-ns timescale.

Oral Fr-A2.5 16:30

Dual-comb thin-disk laser oscillator based on polarization splitting: concept and noise evaluation — •Norbert Modsching, Jakub Drs, Julian Fischer, Pierre Brochard, Stéphane Schilt, Valentin J. Wittwer, and Thomas Südmeyer — Laboratoire Temps-Fréquence, Institut de Physique, Université de Neuchâtel, Neuchâtel, Switzerland

We present a novel scheme for dual-pulse-train operation in a single thin-disk laser cavity. We report on the first f_{CEO} measurement of such systems. A detailed noise evaluation in free-running laser operation indicates the f_{rep} as dominating contribution and that a sub-50-kHz optical linewidth within 1-millisecond measurement time is expected.

Oral Fr-A2.6 16:45

Highly efficient cryogenically cooled 110-W 946-nm Nd:YAG laser — Gholamreza Shayeganrad[1], Silvia Cante[1], Jorge Pelegrin Mosquera[2], Wendel Bailey[2], and •Jacob Mackenzie[1] — [1]Optoelectronics Research Centre, University of Southampton, Southampton SO17 1BJ, UK — [2]Institute of Cryogenics, University of Southampton, Southampton SO17 1BJ, UK

We report a cryogenically cooled Nd:YAG laser operating at 946 nm. Direct in-band pumped at 868 nm the laser produced >110-W output power with a slope efficiency of 80%, with respect to absorbed pump power, and an optical-to-optical efficiency of 74%, with respect to incident power.

17:00–17:15: Closing remarks

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