6th EPS-QEOD Europhoton Conference

# EUROPHOTON

SOLID-STATE, FIBRE, AND WAVEGUIDE COHERENT LIGHT SOURCES

www.europhoton.org

CONFERENCE DIGEST

University of Neuchâtel,
FLSH - Faculté des Lettres
et Sciences Humaines
Neuchâtel, Switzerland

**24 - 29 August 2014**

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## Digest and Copyright Information

The papers included in this digest comprise the short summaries of the 6th EPS-QEOD EUROPHOTON Conference held in Neuchâtel, Switzerland from 24 to 29 August 2014. The extended version of the papers (1-page summaries in pdf format) will be made available on line during a time period of 2 months beginning from the conference. A link with login and password is provided on a separate sheet.

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.



**Europhysics Conference Abstracts Volume 38 E, ISBN: 2-914771-89-4**


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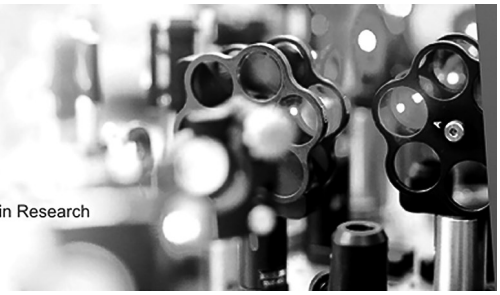

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The Active Fiber Systems GmbH is located in Jena, known as ‘city of photonics’ in Germany. As a spin-off from the Fraunhofer IOF Jena and the Institute of Applied, Physics at the University of Jena the Active Fiber Systems GmbH represents the expertise of innovative solid-state laser development.

The mission of Active Fiber Systems GmbH is to transfer experimental results to reliable laser systems suitable for scientific and industrial applications. Among the extra-ordinary features of pulsed fiber lasers from AFS are compact dimensions, considerably reduced production costs as well as flexible and outstanding laser parameters, which can be customized.

AFS‘s product portfolio includes:

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activefiber systems


High performance ultrafast fs fiber laser


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**www.afs-jena.de | contact@afs-jena.de**

## List of Exhibitors

Technology center for "Route des Lasers" competitiveness cluster, **ALPhANOV** accompanies innovation.
7 areas of excellence: Laser micromachining; Laser sources; Fiber components; Laser and optical systems; Imaging and vision; Light/Living tissues interaction; Technological support.

**http://www.alphanov.com/**

**A·P·E Angewandte Physik & Elektronik GmbH** develops and manufactures measurement devices and other accessoiries for ultrafast laser systems. The company is one of the international market leaders in ultrafast laser technology from autocorrelators to wavelength measurement, from acoustooptics to synchronously pumped optical parametric oscillators (OPOs).

**http://www.ape-berlin.de/**

**Coherent, Inc.** is a Standard & Poor's SmallCap 600 and a Russell 2000Index company and a world leader in providing laser-based solutions to commercial and scientific research markets. Headquartered in Santa Clara, CA USA it employs more than 2.300 employees at 10 manufacturing sites in North America, Europe and Asia.

**http://www.coherent.com/**

**EKSPLA** features more than 20 years experience and focuses on manufacturing of advanced solid-state pulsed lasers, laser systems, ultrafast fiber lasers, optoelectronics and power supplies for researchers and OEM manufacturers

**http://www.ekspla.com/**

**NUFERN** is a leading U.S. manufacturer of specialty optical fibers, precision wound optical fiber coils, fiber lasers and amplifiers. Our integrated team has the experience, resources, and facilities required to design, manufacture, test and qualify highly-engineered optical fibers and fiber-based products for diverse applications and industries

**http://www.nufern.com**

## List of Exhibitors

**NKT photonics** A/S is the result of a merger in 2009 between Crystal Fibre A/S – the largest commercial supplier of micro-structured specialty fiber and Koheras A/S – the leading company within ultra precise fiber lasers and SuperK Supercontinuum White Light Lasers.

**http://www.nktphotonics.com/**

**Onefive GmbH** is a leading supplier of industrial-grade, low-noise femtosecond and picosecond laser modules. The company's strong expertise allows it to provide sub-100 fs ultra-low noise mode-locked lasers from pulse-on-demand up to 1.25 GHz repetition rate. A unique packaging technology offers compact, air-cooled and maintenance-free lasers for a wide range of applications.

**http://www.onefive.com**

**TOPTICA** is a privately held technology driven company, which develops, produces and sells diode and ultrafast fiber lasers for scientific and industrial applications.

**http://www.toptica.com/**

**TRUMPF Scientific Lasers GmbH + Co. KG** is a Joint Venture between TRUMPF and Professor Dr. Ferenc Krausz, Director Max-Planck-Institute for Quantum Optics Garching, Munich. We are a high-tech company focusing on high-power femtosecond laser technology especially on optic parametric amplifiers and high energy picosecond lasers. Base technology is the TRUMPF disk laser technology.

**http://www.trumpf-scientific-lasers.com/en.html**

**VENTEON Laser Technologies GmbH** is a leading-edge manufacturer of high-end femto-second Ti:Sapphire laser systems and equipment. The products range from femtosecond oscillators with sub-6-fs pulse duration to high energy laser systems and OPCPA solutions with dedicated seed laser systems. The product line is completed by pulse characterization tools, ultrafast optics and accessories.

**http://www.venteon.com**

## General Information

### Introduction

The **Europhoton** conference features the latest breakthroughs in the field of Solid-State, Fibre, and Waveguided Light Sources. The conference will be held in **University of Neuchâtel - Faculty of Humanities (Faculté des Lettres et Sciences Humaines)**, Espace Louis-Agassiz, 1, **Neuchâtel, Switzerland** close to the city centre with all attractions easily accessible by foot or by excellent public transportation. World-renowned researchers discuss the latest developments in the scientific community accompanied by Summer School sessions at the PhD student and postdoct level, and by informal breakout sessions for discussion and company display. This conference will also feature a half-day special Symposium on "Lasers for Biomedical Imaging and Sensing" where prominent Keynote and Invited Speakers will discuss state of the art and future visions for this fascinating field. The sixth 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** and the University of Neuchâtel in cooperation with the Quantum Electronics and Optics Division (QEOD) of EPS.

**The Conference Programme includes:**

- **The Summer School on Frontiers of Solid State Light Sources**
  *from Sunday 24 August (afternoon) to Monday 25 August 2014 (all day)*

- **The main Conference on Solid-State, Fibre, and Coherent Light Sources**
  *from Tuesday 26 August (morning) to Friday 29 August 2014 (noon)*

- **A half-day special Symposium on "Lasers for Biomedical Imaging and Sensing"**
  *on Wednesday 27 August 2014 (morning).*

The 6th EPS-QEOD Europhoton Conference 2014 technical programme includes keynote, invited and selected contributed papers completely encompassing the field of lasers and photonics. All aspects of the technologies will be covered, including fundamentals, device development, systems, and applications.

Short abstracts of the papers to be presented at the EPS-QEOD Europhoton Conference 2014 appear in this programme. 205 presentations (6 Summer School lectures, 3 keynotes, 12 invited including 1 upgrade, 73 orals, and 111 poster presentations from Europe and overseas) have been selected for presentation at the Conference.

### Tabletop Exhibit

**A tabletop exhibit will be organised from Tuesday 26 August (morning) to Thursday, 28 August (afternoon).** It will take place at the University of Neuchâtel, Faculty of Humanities (Faculté des Lettres et Sciences Humaines) in the Cafeteria. It will be co-located with coffee breaks. This exhibition will allow laser and photonics related companies to present and promote their new products among attendees.

### Summer School

The Europhoton Conference includes a Summer School on **"Frontiers of Solid-State Light Sources"**. The Summer School will be held **from Sunday 24 August (afternoon) to Monday 25 August (all day)**, 2014. PhD Students and Postdocs who have paid the conference fee are especially invited to attend the Summer School. They will receive free entrance to the School. The same rule will be applied for the full paying conference participants. Lecturers who are internationally renowned in their research subjects will present the lecture programme. The Summer School will give students a chance to get introduced into various laser related subjects, covering the basics up to the latest research results.

### Poster Sessions

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. To allow participants to see as many posters as possible, **3 sessions are organised from Tuesday 26 to Thursday 28 August 2014** in the afternoon. All posters will be displayed in rooms located next to the main lecture hall when crossing the outdoor courtyard. There will be no presentations during this time.

Each author is provided with one bulletin board. Poster size should be portrait format A0 (120 cm high × 80 cm wide). The boards will be marked with the paper session code. **All authors are requested to display posters on their allocated boards in the morning of the day of their presentation.** Fixing material (tape or pins) will be provided. Posters still in their places in the evening will be removed and discarded by the conference organisation. In order to present their work and answer questions, authors are requested to be present in the vicinity of their poster during the poster session. The schedule of the poster sessions is presented on the respective pages of this programme.

### Speakers' Information

**Speakers are asked to check-in with the session presider in the conference room ten minutes before the session begins.**

**Total length of the talks:**

**Keynote presentations:** 45 minutes presentation including 10 minutes for discussion.
**Invited presentations:** 30 minutes presentation including 10 minutes for discussion.
**Oral presentations:** 15 minutes presentation including 5 minutes for discussion.

A computer with Windows 7, Microsoft Pack Office (for ppt format files) and Adobe Reader (for pdf format file) will be available. Authors will transfer their presentation files by USB memory stick or CD-Rom.

All oral sessions take place in the main auditorium so called Aula des jeunes-rives of the Faculty of Humanities (Faculté des Lettres et Sciences Humaines - FLSH).

### Conference Language

English will be the official conference language.

### Technical Digest

The registration fee includes an on line technical digest including the one-page summaries.

### Social Programme

Each registered participant is cordially invited to attend the social programme as detailed on page 07. Tickets will be included in the registration package. Conference participants will need to go to each site on their own (no shuttle organised).

**A map on page 08 shows the location of the different events.**

## WELCOME RECEPTION

*Monday 25 August 2014, 18:30 - 20:45*

The event will begin in the "Salle du Grand Conseil" where **Gisela Eckhardt**, *Hughes Research Labs, Malibu, USA*, will present an invited talk on **"History of the Discovery of the Stimulated Raman Effect at the Hughes Research Laboratories"**.

The event will be hosted at the **Neuchâtel Castle**. Address: Château de Neuchâtel, Château 1, 2000 Neuchâtel. The castle is at walking distance from the conference venue.

**We thank the Canton of Neuchâtel for their kind sponsoring of the event.**

## BOAT TRIP

*Tuesday 26 August 2014, 18:30 - 20:15*

**The boat will depart at exactly 18:30. Be there on time with your badge!**

**Address:** "Port de la Ville" - Harbour of Neuchâtel

**You find the harbour when you follow the lake boarder on the direction of the City centre.**

## CONFERENCE DINNER

*Wednesday 27 August 2014, 19:15 - 21:30.*

The conference dinner will take place at the Hotel DuPeyrou (http://www.dupeyrou.ch/).

**Address:** Hotel DuPeyrou, Avenue DuPeyrou 1, CH-2000 Neuchâtel (phone 00 41 32 725 11 83). Close to "Jardin du Palais DuPeyrou". Location at the intersection of Faubourg de l'Hôpital, Avenue Jean-Jacques Rousseau and Avenue DuPeyrou.

## Conference & Social Programme Locations

The conference will take place at the University of Neuchâtel, in the Faculty of Humanities (Faculté des Lettres et Sciences Humaines - FLSH).

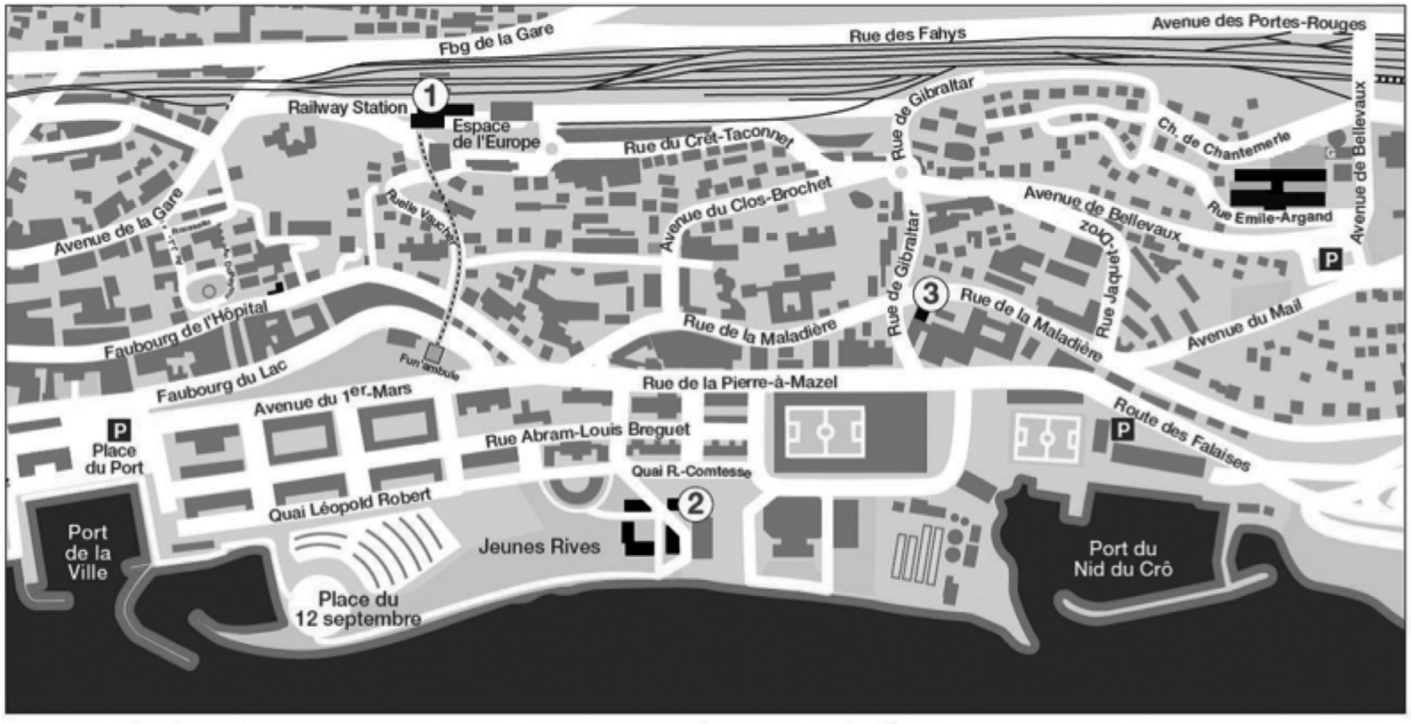
**Address:** Espace Louis-Agassiz, 1, CH-2000 Neuchâtel, Switzerland
**Phone:** +41 32 718 10 9

All oral sessions take place in the **Aula des Jeunes-Rives room**.

All poster sessions take place in rooms located next to the main lecture hall when crossing the outdoor courtyard.

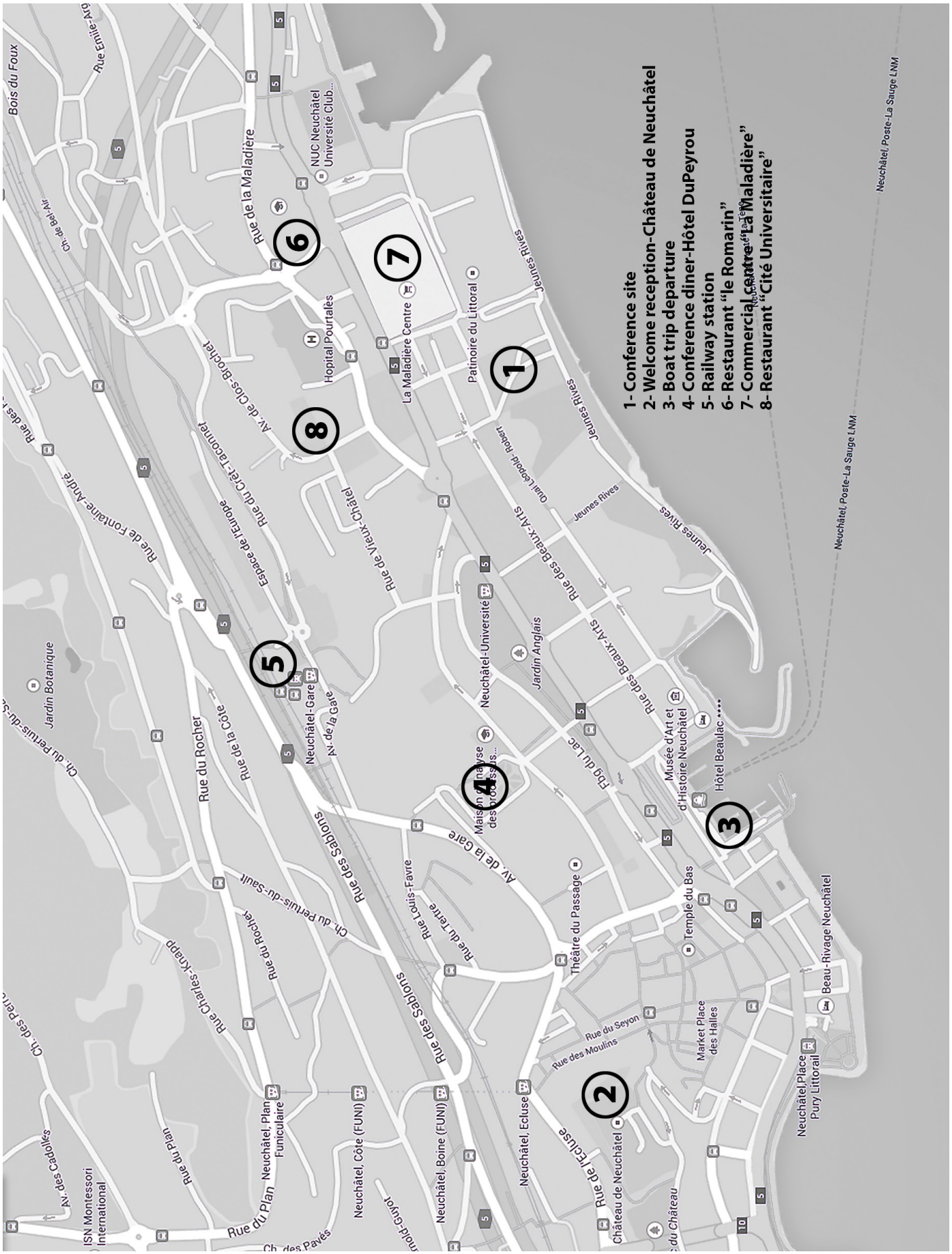
Exhibition and coffee breaks take place in the **Cafeteria.**

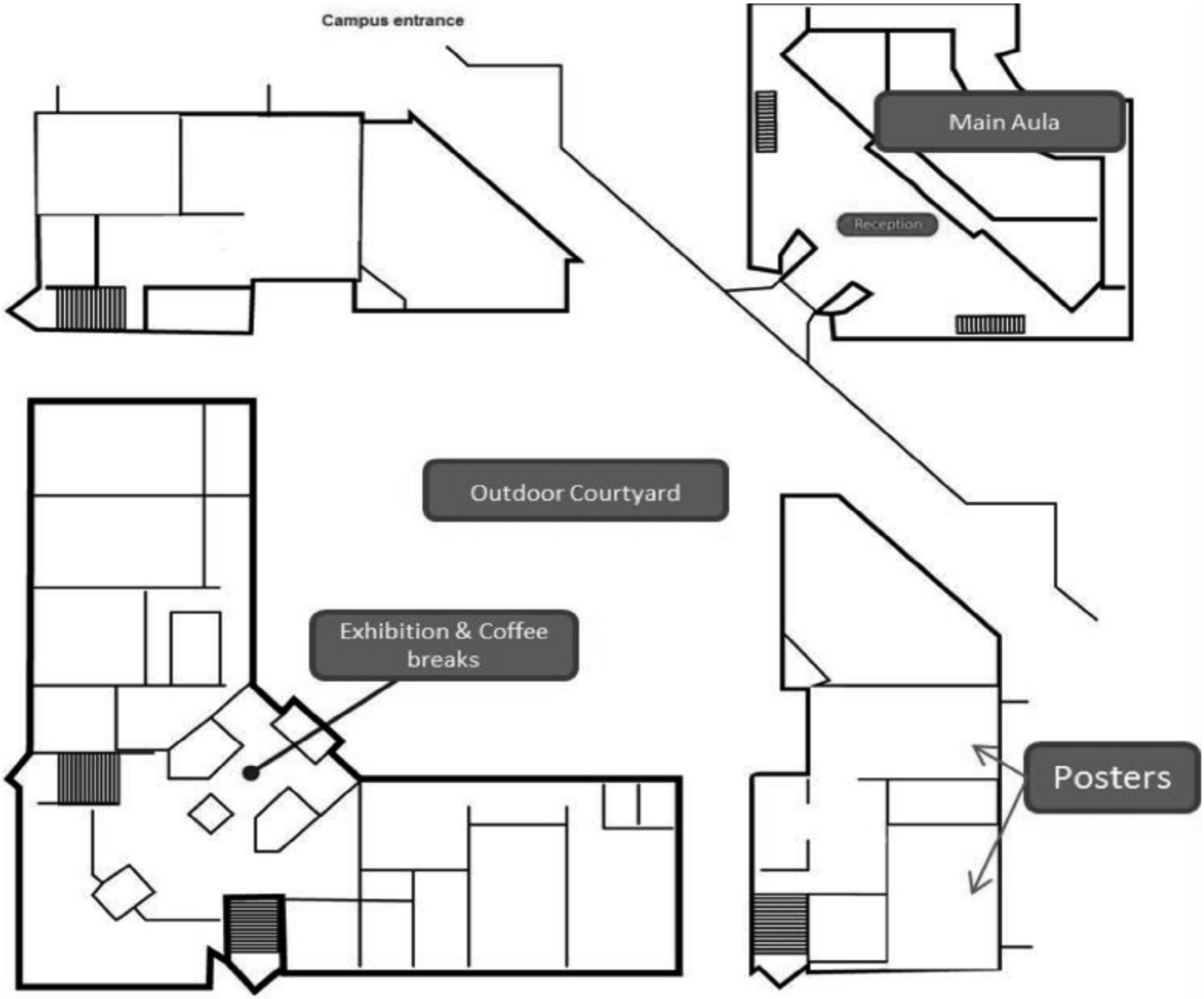
## Site Plan




1. Gare / Railway Station
2. Congress site : Aula des Jeunes-Rives
3. Restaurant le Romarin

## Europhoton 2014 all different locations








## On-Site Facilities

Wireless internet is available inside the building of the conference centre with free access. A message board around the registration area will be installed.

## Lunches

Lunches are not included in the registration fees.
**No lunch (in any form) is possible inside the conference room.**
The restaurant **Le Romarin** will be open (see location on pages 07-08). A commercial centre **"La Maladière"** (http://www.maladierecentre.ch/maladiere/accueil/index.aspx) located by the "stade de la Maladière" offers several possibilities to have lunch there (COOP restaurant, Piazza restaurant, Mezzo di Pasta). The restaurant **"Cité Universitaire"** is also open (see location on page 08). Several additional restaurants are also located at a short walking distance from the conference venue.

## Coffee Breaks

Coffee breaks take place in the Cafeteria located opposite of the lecture room when crossing the outdoor courtyard. The exhibition will take place at the same time.

**ATTENTION!!**
**It is completely forbidden to eat or drink in the conference room.**

## Registration Information

The registration fees for the meeting include:
- Admission to all technical sessions of the main conference on **"Solid-State, Fibre, and Waveguide Coherent Light Sources"**, as well as to the half-day **special symposium on "Lasers for Biomedical Imaging and Sensing"** which will take place on Wednesday morning 27 August 2014.
- Admission to the **Summer School on "Frontiers of Solid-State Light Sources"**: PhD Students and Postdocs who have paid the conference fee are especially invited to attend the Summer School. They will receive free entrance to the School. The same rule will be applied for the full paying conference participants.
- **On line digest** including the one-page summaries.
- **Welcome Reception, Boat Trip and Conference Dinner** as mentioned in the Social Programme.
- **Entrance to the exhibition**.
- **Coffee breaks** as mentioned in the programme.

Lunches are not included. Tickets for public transports are not included.

As a rule, due to space limitations and necessary advance reservation, on site registrants may not be able to attend the social programme. No fee reduction will be applied. Also, no guest tickets can be obtained on site.

## Conference Registration Hours:

| | |
|---|---|
| Sunday 24 | 12:00–17:00 |
| Monday 25 | 07:30–12:00 // 13:00–17:00 |
| Tuesday 26 | 07:30–12:00 // 13:15–16:30 |
| Wednesday 27 | 07:45–11:45 // 13:00–16:30 |
| Thursday 28 | 07:45–11:45 // 13:00–16:30 |
| Friday 29 | closed |

## Conference Hours

| | |
|---|---|
| Sunday 24 | 14:00–18:30* |
| Monday 25 | 08:00–12:30* // 13:30–18:00* |
| Tuesday 26 | 08:00–12:45 // 13:45–18:15 |
| Wednesday 27 | 08:00–12:15 // 13:15–18:45 |
| Thursday 28 | 08:00–12:15 // 13:15–20:00 |
| Friday 29 | 08:00–12:45 |

** Summer School*

## Coffee Breaks

| | |
|---|---|
| Sunday 24 | 16:00–16:30 |
| Monday 25 | 10:00–10:30 // 15:30–16:00 |
| Tuesday 26 | 10:15–10:45 // 14:45–16:15* |
| Wednesday 27 | 10:00–10:30 // 15:30–17:00* |
| Thursday 28 | 10:00–10:30 // 15:15–16:45* |
| Friday 29 | 10:00–10:30 |

** held in conjunction with the poster session*

## Lunch Breaks

| | |
|---|---|
| Monday 25 | 12:30 – 13:30 |
| Tuesday 26 | 12:45 – 13:45 |
| Wednesday 27 | 12:15 – 13:15 |
| Thursday 28 | 12:15 – 13:15 |

## Social Programme

**WELCOME RECEPTION AND INVITED TALK**
**Monday 25 August 2014**
*18:30 – 20:45 // Château de Neuchâtel*

**BOAT TRIP**
**Tuesday 26 August 2014**
*18:30 – 20:15 // Port de la Ville*

**CONFERENCE DINNER**
**Wednesday 27 August 2014**
*19:15 – 21:30 // Hotel DuPeyrou*

## Special Event

**PRIZE FOR RESEARCH IN LASER SCIENCE AND APPLICATIONS CEREMONY AND LECTURE**
**Tuesday 26 August 2014**
*13:45 – 14:45 // Aula des Jeunes-Rives*

# Conference Committees

**General Chair:**
**Thomas Südmeyer,**
*University of Neuchâtel, Neuchâtel, Switzerland*

**Programme Chair:**
**Ingmar Hartl,**
*DESY Hamburg, Hamburg, Germany*

**Local Chairs:**
**Sandrine Gouinguené, Maxim Gaponenko and Stéphane Schilt,**
*University of Neuchâtel, Neuchâtel, Switzerland*

## Programme Sub-Committee "Solid-State Lasers"

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**Majid Ebrahim-Zadeh,**
*The Institute of Photonic Sciences, Barcelona, Spain*

**Shekhar Guha,**
*Air Force Research Laboratory, Materials and Manufacturing Directorate, Wright Patterson Air Force Base, Ohio, USA*

**Christian Kränkel,**
*University of Hamburg, Hamburg, Germany*

**Marco Marangoni,**
*Politecnico di Milano, Milan, Italy*

**Uwe Morgner,**
*University of Hannover, Laser Zentrum Hannover, Hannover, Germany*

**Fabian Rotermund,**
*Ajou University, Suwon, South Korea*

**Alphan Sennaroğlu,**
*Koç University, Istanbul, Turkey*

## Programme Sub-Committee "Fibre and Waveguide Devices"

**CHAIR: F. Ömer Ilday,**
*Bilkent University, Ankara, Turkey*

**Igor Bufetov,**
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**Francesc Díaz,**
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**Phillipe Grelu,**
*Université de Bourgogne, Dijon, France*

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**John Travers,**
*Max Planck Institute for the Science of Light, Erlangen, Germany*

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*Royal Institute of Technology, KTH, Stockholm, Sweden*

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**Paolo Laporta,**
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**Richard Moncorgé,**
*University of Caen, France*

**Thomas Südmeyer,**
*University of Neuchâtel, Switzerland (ex officio)*

## Conference Management

The Conference management is provided by the European Physical Society, 6 rue des Frères Lumière, 68200 Mulhouse, France.
This programme is edited by P. Helfenstein, A. Ouarab and X. de Araujo.


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## Neuchâtel

Neuchâtel has slightly over 32,800 inhabitants (60,000 including the surrounding area), and lies on the North Western shores of the largest Swiss inland lake at an altitude of 430 metres, located between the Jura Mountains and the Alps. It is one of the main towns in the French-speaking region of Switzerland, also called Suisse Romande. The other national languages are German (70%), Italian and Romansh. The town is ideally located halfway between Zürich and Geneva. Renowned for its watch industry, Neuchâtel has been able to position itself as the heart of micro-technology and high-tech industry. During the last 20 years, the region of Neuchâtel has attracted many leading companies in the high-tech sectors such as medical technology, micro-technology, biotechnology, machines and equipment, IT and clean technologies.
Neuchâtel is an ideal place for full-time study or high-level research work, in an idyllic setting at the heart of Europe. The city hosts around 4,000 students. As a result, you'll find a young and cosmopolitan atmosphere, with plenty of things to see and do. Neuchâtel is home to the French speaking University of Neuchâtel. The University has five faculties (schools) and more than a dozen institutes, including arts and human sciences, natural sciences, law, economics and technology. The Faculty of Arts and Human Sciences is the largest school of those that comprise the University of Neuchâtel with 1,500 students. With beautiful historic architecture, numerous coffee shops, restaurants and bars, Neuchâtel is also close to many forests, some of which offer attractive lakeside walks. There are 32 sites in Neuchâtel that are listed as Swiss heritage site of National Significance. The entire old city is part of the Inventory of Swiss Heritage Sites.
The city is home to several museums, including a Museum of natural history (English information), an art and history Museum (English information) and a Museum of ethnography (English information). As well, one can take a stroll along the shoreline paths of "Lac Neuchâtel". The three-lake region can be visited during a cruise (Navigation SA). The lake is also suitable for swimming, although it can be quite chilly. There is a succession of beaches around Neuchâtel. The nearest from downtown are Serrières (Quai Max Petit-Pierre - Tram stop Champ-Bugin) and Jeunes Rives (close to the conference hall). Other places, such as the Botanical Garden (bus no. 109 from town centre (Ermitage stop), then 10 minutes on foot, Free entry) or the Jaquet-Droz Automates (located at the art and history museum) are worth a visit.


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### Get Around

Public transportation in Neuchâtel is fairly good. The city has reliable bus, tram and train schedule running throughout the city itself as well as the many outlying communities, as well as other towns in the area. All bus lines converge at the main square of the city, Place Pury. Neuchatel's network, time and schedules can be seen via www.transn.ch/fr/reseau-horaires/litt.html (site only available in French).
You can buy a ticket from any of the bus stations and there is a 24 hours pass for CHF 7.00 that allows you to use any transport in the Neuchâtel area for 24 hours from the time of issue.

### Currency

The Swiss Currency is the Swiss Franc.

### Weather

The climate in Switzerland is typically temperate. The temperatures are mild in summer. End of August may be nice but occasional showers may happen.

## Programme at a Glance

### Sunday 24 August 2014 (Summer School)

**SS1** **14:00 - 16:00** **Summer School Lecture 1**
***Jörg Rossbach**, Hamburg University and DESY, Hamburg, Germany*
**"Introduction to the Physics of XUV and X-ray Free-Electron Lasers"**

**16:00 - 16:30** **Coffee Break**

**SS2** **16:30 - 18:30** **Summer School Lecture 2**
***Tobias Kippenberg**, École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland*
**"Microresonator Based Optical Frequency Combs"**

### Monday 25 August 2014 (Summer School)

**SS3** **08:00 - 10:00** **Summer School Lecture 3**
***Markus Pollnau**, University of Twente, MESA+ Institute for Nanotechnology, Enschede, The Netherlands*
**"Continuous-wave Lasers: Theory and Implementation in Rare-earth-doped Waveguides"**

10:00 - 10:30 Coffee Break

**SS4** **10:30 - 12:30** **Summer School Lecture 4**
***Alan Kemp**, Fraunhofer UK, University of Strathclyde, Institute of Photonics, Glasgow, United Kingdom*
**"Applications of Diamond to Solid-state Laser Engineering"**

12:30 - 13:30 Lunch Break

**SS5** **13:30 - 15:30** **Summer School Lecture 5**
***Siddharth Ramachandran**, Boston University, ECE Department, Photonics Center, Boston, MA, USA*
**"Physics of Guided-wave Light Propagation: Applications to Fiber Lasers and Nonlinear Optics"**

15:30 - 16:00 Coffee Break

**SS6** **16:00 - 18:00** **Summer School Lecture 6**
***Miles Padgett**, School of Physics and Astronomy, Optics group, University of Glasgow, United Kingdom*
**"An Introduction to Structured Light and its Applications"**

18:15 - 18:30 Walk to Castle

**18:30 - 20:45** **Welcome Reception and Invited Talk:**
***Gisela Eckhardt**, Hughes Research Labs, Malibu, CA, USA*
**"History of the Discovery of the Stimulated Raman Effect at the Hughes Research Laboratories"**

### Tuesday 26 August 2014 (Conference)

**08:00 - 08:15** **Welcome presented by Thomas Südmeyer and Ingmar Hartl**

**TuA** **08:15 - 10:15** **OPCPA and Pump Systems (Oral Session)**

10:15 - 10:45 Coffee Break

**TuB** **10:45 - 12:45** **Novel Pulsed Fiber Sources (Oral Session)**

12:45 -13:45 Lunch Break

**TuPr** **13:45 - 14:45** **Prize for Research in Laser Science and Applications - Ceremony and Lecture (Oral Session)**

**TuP** **14:45 - 16:15** **Poster Session 1 with Coffee Break**

**TuC** **16:15 - 18:15** **High-Power Yb-doped Amplifiers (Oral Session)**

18:15 - 18:30 Walk to Harbour

18:30 - 20:15 Boat Trip

### Wednesday 27 August 2014 (Conference)

**WeA** **08:00 - 10:00** **Lasers for Spectroscopy, Sensing and Imaging (Oral Session - Special symposium)**

10:00 - 10:30 Coffee Break

**WeB** **10:30 - 12:15** **Brain and Infrared Lasers (Oral Session - Special symposium)**

12:15 - 13:15 Lunch Break

**WeC** **13:15 - 15:30** **Power-Scaling of Thin-Disk Lasers (Oral Session)**

**WeP** **15:30 - 17:00** **Poster Session 2 with Coffee Break**

**WeD** **17:00 - 18:45** **Waveguide- and Microresonator-based Sources (Oral Session)**

18:45 - 19:15 Break and Walk to Dinner

19:15 - 21:30 Conference Dinner

## Thursday 28 August 2014 (Conference)

| | | |
|---|---|---|
| **ThA** | **08:00 - 10:00** | **Novel Fiber Amplifiers (Oral Session)** |
| | 10:00 - 10:30 | Coffee Break |
| **ThB** | **10:30 - 12:15** | **Frequency Combs and Supercontinua (Oral Session)** |
| | 12:15 - 13:15 | Lunch Break |
| **ThC** | **13:15 - 15:15** | **Low-noise Fiber Lasers and Spectroscopy (Oral Session)** |
| **ThP** | **15:15 - 16:45** | **Poster Session 3 with Coffee Break** |
| **ThD** | **16:45 - 18:45** | **Crystalline-host Lasers (Oral Session)** |
| | 18:45 - 19:15 | Coffee Break |
| **ThE** | **19:15 - 20:00** | **Postdeadline Session (Oral Session)** |

## Friday 29 August 2014 (Conference)

| | | |
|---|---|---|
| **FrA** | **08:00 - 10:00** | **Fiber Sources for High-field Experiments (Oral Session)** |
| | 10:00 - 10:30 | Coffee Break |
| **FrB** | **10:30 - 12:30** | **Semiconductor and Microchip Lasers (Oral Session)** |
| | 12:30 - 12:45 | Closing Remarks |

# Keynote and Invited Talks at a Glance

## Monday 25 August 2014

**18:30** Invited Talk held during the Welcome Reception
**History of the Discovery of the Stimulated Raman Effect at the Hughes Research Laboratories** – *Gisela Eckhardt*

## Tuesday 26 August 2014

**08:15** **Frequency Domain Optical Parametric Amplification of nJ Laser Pulses** – *Francois Légaré*

**10:45** **Recent Advances in Mid-Infrared Fiber Lasers** – *Martin Bernier*

**13:45** **Femtosecond Frequency Combs and Applications** – *Thomas Udem*

**16:15** **Flexible Burst-mode Ultrafast Pump-probe Laser for User Experiments at the European X-Ray Free-Electron Laser Facility** – *Max Lederer*

## Wednesday 27 August 2014

**08:00** **Frequency Comb Measurements Outside the Laboratory** – *Nathan Newbury (Keynote)*

**09:00** **Fourier Domain Mode Locking (FDML) for Multi-Megahertz Optical Coherence Tomography (OCT) and Hyperspectral Stimulated Raman Imaging** – *Robert Huber*

**10:30** **Fiber-based Sources for Brain Imaging** – *Chris Xu*

**11:00** **Looking Inside the Brain: A fiber-optic Platform for Neurophotonics** – *Aleksei Zheltikov*

**13:15** **Innovative Opportunities for combined High Average and High Peak Power Lasers** – *John Collier (Keynote)*

**14:00** **Power-scaling of Kerr-lens Mode-locked Yb:YAG Thin-disk Oscillators** – *Jonathan Brons*

## Thursday 28 August 2014

**08:00** **Performance Scaling of Ultrafast Fiber Laser Systems** – *Jens Limpert (Keynote)*

**08:45** **Ultrashort-pulse Enhancement Cavities and Applications** – *Ioachim Pupeza*

**16:45** **Micro Domain-controlled Laser Materials Toward Giant Micro-photonics** – *Takunori Taira*

## Friday 29 August 2014

**08:00** **Extreme Nonlinear Optics with Kagome Hollow-core PCF** – *Fetah Benabid*

## Summer School – Technical Programme

### Sunday 24 August 2014

**Summer School Lecture 1** **14:00 - 16:00**

| | |
|---|---|
| 14:00-14:45 | Summer School Lecture 1 |
| 14:45-15:00 | Break |
| 15:00-15:45 | Summer School Lecture 1, continued |
| 15:45-16:00 | Discussion 1 |

**Jörg Rossbach**
*Hamburg University and DESY, Hamburg, Germany*

**Topic: Introduction to the Physics of XUV and X-ray Free-Electron Lasers**
State-of-the-art electron accelerators can drive free-electron lasers (FELs) in a wide range of wavelength from the far infrared down to the Xray regime. This lecture will cover the physics of FELs, with emphasis on the single-pass high-gain FEL principle. In addition to the basic physics, technology requirements will be discussed, as well as typical performance values of existing facilities. Statistical properties of the photon pulse in SASE FEL mode will be covered as well as progress and plans for advanced schemes improving the pulse properties, such as various FEL seeding concepts or single-mode operation.

**16:00 - 16:30** **Coffee Break (Cafeteria)**

**Summer School Lecture 2** **16:30 - 18:30**

**16:30-17:15 Summer School Lecture 2**
**17:15-17:30 Break**
**17:30-18:15 Summer School Lecture 2, continued**
**18:15-18:30 Discussion 2**

**Tobias Kippenberg**
*École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland*

**Topic: Microresonator Based Optical Frequency Combs**
Optical frequency combs provide equidistant markers in the IR, visible and UV and have become a pivotal tool for frequency metrology and are the underlying principle of optical atomic clocks, but are also finding use in other areas, such as broadband spectroscopy, low noise microwave generation or LIDAR. Frequency combs are conventionally generated by using the periodic train of pulses from a modelocked laser. In 2007 a new method to generate optical combs was discovered based on optical microresonators. Microresonator frequency combs have emerged as a new technology with which combs can be generated via parametric frequency conversion of a continuous wave (CW) laser inside a high Q resonator via the Kerr nonlinearity. Over the past years a detailed understanding of the comb formation process has been gained, and regimes identified in which dissipative temporal solitons can be generated, that not only provide low noise optical frequency combs but moreover give access to femtosecond pulses. Micro-resonator frequency combs offer high repetition rates in the technologically relevant GHz regime. Moreover the parametric gain is broadband enabling frequency combs that can extend over a full octave without external broadening. In addition, micro-resonators are amenable to planar integration allowing further electronic and optical integration on a chip. The developments at EPFL will be reviewed, and results using SiN planar microring resonators and ultra high Q crystalline $MgF_2$ resonators presented. In particular low noise broadband comb operation will be discussed, their use in coherent telecommunications and the extension of these Kerr frequency combs to the mid-IR, as well as recently discovered femtosecond pulse generation using temporal soliton formation and ongoing work towards low phase noise microwave generation. Moreover, the vision of future RF-to-optical links on a chip will be discussed and the outstanding challenges in this developing field.

### Monday 25 August 2014

**Summer School Lecture 3** **08:00 - 10:00**

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|---|---|
| 08:00-08:45 | Summer School Lecture 3 |
| 08:45-09:00 | Break |
| 09:00-09:45 | Summer School Lecture 3, continued |
| 09:45-10:00 | Discussion 3 |

**Markus Pollnau**
*University of Twente, MESA+ Institute for Nanotechnology, Enschede, The Netherlands*

**Topic: Continuous-wave Lasers: Theory and Implementation in Rare-earth-doped Waveguides**
During the first half of this lecture I will extend the theory of continuous-wave (cw) lasers by systematically considering spontaneous emission as a result of vacuum fluctuations. Its inherent consequence that in a cw laser the gain is smaller than the losses necessitates that any coherent state inside a cw laser decays with one-half the coherence time of the emitted laser light and straightforwardly leads us to the definition of the finite Q-factor of a cw lasing resonator and the derivation of the laser linewidth. I will introduce the laser eigenvalue which relates the parameters of a cw lasing resonator to the corresponding

parameters of the underlying passive resonator, thereby unifying resonator and laser theory, and show that the Schawlow-Townes linewidth is a three-fold approximation and does not represent a lower limit to the fundamental laser linewidth. During the second half I will discuss recent results on highly efficient rare-earth-doped waveguide lasers, with particular emphasis on ultranarrow-linewidth lasers on a silicon chip and applications to intra-laser-cavity optical sensing.

**10:00 - 10:30** **Coffee Break (Cafeteria)**

## Summer School Lecture 4 — 10:30 - 12:30

**10:30-11:15** **Summer School Lecture 4**
**11:15-11:30** **Break**
**11:30-12:15** **Summer School Lecture 4, continued**
**12:15-12:30** **Discussion 4**

**Alan Kemp**
*Fraunhofer UK, University of Strathclyde, Institute of Photonics, Glasgow, United Kingdom*

**Topic: Applications of Diamond to Solid-state Laser Engineering**
**The lecture will feature:**

1. An overview of the opportunities and challenges of using diamond in solid-state laser engineering.
2. Characterisation of diamond for laser applications (birefringence, loss, damage, Raman gain).
3. The use of diamond to cool conventional laser materials (heat spreaders and the like).
4. The means to exploit diamond directly as a laser material, principally diamond Raman lasers.

**12:30 - 13:30** **Lunch Time**

## Summer School Lecture 5 — 13:30 - 15:30

**13:30-14:15** **Summer School Lecture 5**
**14:15-14:30** **Break**
**14:30-15:15** **Summer School Lecture 5, continued**
**15:15-15:30** **Discussion 5**

**Siddharth Ramachandran**
*Boston University, ECE Department, Photonics Center, Boston, MA, USA*

**Topic: Physics of Guided-wave Light Propagation: Applications to Fiber Lasers and Nonlinear Optics**

A fiber may be characterised by the number of discrete spatial modes it carries, their effective modal areas, and the phase accumulated when they propagate, all of which control interactions between different modes or colours, due to linear (via interference) or nonlinear (via, primarily, the $\chi(3)$ nonlinearity in silica) coupling. These interactions are not unlike those encountered in bulk optical media, but with a fundamental distinction – owing to the revolutionarily low loss of optical fibers, interaction lengths can be several orders of magnitude greater than that feasible with bulk media, and hence no other medium facilitates, with such ease, remote delivery of light. Here, we describe the physics of light propagation in optical fibers, which may guide light due to total internal reflection (as is the case with a majority of fibers, including most photonic crystal fibers) or due to band-gap effects (such as hollow-core bandgap fibers). We will elucidate the key design parameters that allow achieving desired mode areas, nonlinear coefficients, phase and dispersion matching, and show how these can be connected with simple ray-optic and wave-optic theories. Then, we will explore the regimes in which single-mode, mono-mode, few-mode, and vastly multimode fibers, including their vector effects, are applied and exploited. We will end with illustrative examples of applications in which specially designed fibers have been used, focusing on recent advances in nonlinear fiber optics, high-power lasers and imaging applications.

**15:30 - 16:00** **Coffee Break (Cafeteria)**

## Summer School Lecture 6 — 16:00 - 18:00

**16:00-16:45** **Summer School Lecture 6**
**16:45-17:00** **Break**
**17:00-17:45** **Summer School Lecture 6, continued**
**17:45-18:00** **Discussion 6**

**Miles Padgett**
*School of Physics and Astronomy, Optics group, University of Glasgow, United Kingdom*

**Topic: An Introduction to Structured Light and its Applications**

## Keynote and Invited Speakers

### Monday 25 August 2014

**Welcome Reception at the Castle, 18:30 - 20:45**

18:30 - 19:00 (Invited)

**"History of the Discovery of the Stimulated Raman Effect at the Hughes Research Laboratories"**

***Gisela Eckhardt**, Hughes Research Labs, Malibu, USA*

Gisela Eckhardt will present a talk on "History of the Discovery of the Stimulated Raman Effect at the Hughes Research Laboratories"

### Tuesday 26 August 2014

**OPCPA and Pump Systems - 08:15 - 10:15**

08:15 - 08:45 (Invited)

**"Frequency domain Optical Parametric Amplification of nJ laser pulses"**

***Francois Legare**, INRS, Varennes, Canada*

Using Frequency domain Optical Parametric Amplification, 800nm nJ level pulses are amplified 2.000 to 12.000 times in a single 2mm BBO crystal, pumped by picosecond 400nm pulses. Blocking the seed input yielded a 1400 times weaker superfluorescence level.

**Novel Pulsed Fiber Sources - 10:45 - 12:45**

10:45 - 11:15 (Invited)

**"Recent Advances in Mid-Infrared Fiber Lasers"**

***Martin Bernier**, COPL, Laval University, Quebec, Canada*

Recent advances in the development of fiber lasers operating in the mid-infrared will be reviewed. A 30W-level erbium-doped fluoride glass fiber laser emitting in the vicinity of 3μm will be detailed. The conversion of such laser in the 3-4μm window by stimulated Raman scattering in chalcogenide fibers will be demonstrated.

**Prize for Research in Laser Science and Applications, Ceremony and Lecture - 13:45 - 14:45**

14:00 - 14:45 (Invited)

**Femtosecond Frequency Combs and Applications**

***Thomas Udem**, Max-Planck-Institut für Quantenoptik, Garching, Germany*

A femtosecond frequency comb is a simple and compact tool that allows the phase coherent connection of the radio frequency domain (below 10 GHz) with the optical domain (above 200 THz). It greatly simplified high precision optical frequency measurements and provides the long awaited clockwork mechanism for an all-optical atomic clock. In addition it allows to shape the electric field transients of femtosecond pulses including the phase between the carrier wave and the pulse envelope. I will try to give an overview of the technical aspects of frequency combs and their applications.

**High-Power-Yb-doped Amplifiers - 16:15 - 18:15**

16:15 - 16:45 (Invited)

**"Flexible Burst-mode Ultrafast Pump-probe Laser for User Experiments at the European X-Ray Free-Electron Laser Facility"**

***Max Lederer**, European X-Ray Free-Electron Laser-Facility GmbH, Hamburg, Germany*

We present the concept and development status of our pump-probe laser to be installed at experimental stations of the European XFEL. To date, features such as burst-mode operation with intra-burst frequencies up to 4.5MHz and arbitrary pulse selection are demonstrated at single pulse energies up to 180μJ and 15fs pulsewidth.

### Wednesday 27 August 2014

**Lasers for Spectroscopy, Sensing and Imaging - 08:00 - 10:00**

08:00-08:45 (Keynote)

**"Frequency Comb Measurements Outside the Laboratory"**

***Nathan Newbury**, NIST, Boulder, United States*

Frequency combs have been exploited in an expanding range of precision measurements, but so far primarily within the metrology laboratory. I will discuss development of a fieldable frequency comb, and experiments that send comb light across outdoor air paths to explore both accurate atmospheric gas measurements and optical time-frequency transfer.

09:00 - 09:30 (Invited)

**"Fourier Domain Mode Locking (FDML) for Multi-Megahertz Optical Coherence Tomography (OCT) and Hyperspectral Stimulated Raman Imaging"**

***Robert Huber**, Institut für Biomedizinische Optik, Universität zu Lübeck, Lübeck, Germany*

Fourier Domain Mode Locked lasers use a kilometer long fiber cavity to generate very rapid, narrow linewidth wavelength sweeps over a wide spectral range. These lasers enable optical coherence tomography at Megahertz line rate (MHz-OCT) and time encoded molecular stimulated Raman (Ti-Co-Raman) microscopy.

**Brain and Infrared Lasers - 10:30 - 12:15**

10:30 - 11:00 (Invited)

**"Fiber-based Sources for Brain Imaging"**

***Chris Xu**, School of Applied and Engineering Physics, Cornell University, Ithaca, NY USA*

Deep tissue multiphoton microscopy (MPM) using solitons generated from optical fibers are reviewed. The main characteristics of the excitation source for deep tissue MPM, such as wavelength, pulse energy, and repetition rate, are discussed.

11:00 - 11:30 (Invited)

**"Looking Inside the Brain: A fiber-optic Platform for Neurophotonics"**

***Aleksei Zheltikov**, Moscow State University, Kurchatov Institute National Research Center, Moscow, Russia & Texas A&M University, College Station, TX, United States*

New fiber-optic neurointerfaces are shown to offer a unique tool for continuous online quantitative monitoring of transcription factor dynamics in the brain of freely behaving mice, suggesting new ways toward understanding neuron plasticity, learning, and memory.

**Power Scaling of Thin Disk Lasers - 13:15 - 15:30**

13:15 - 14:00 (Keynote)

**"Innovative Opportunities for combined High Average and High Peak Power Lasers"**

***John Collier**, Central Laser Facility STFC Rutherford Appleton Laboratory, Oxfordshire, United Kingdom*

In this presentation I will briefly report on the development of a new diode pumped high energy laser concept at the Rutherford Appleton Laboratory (RAL). Known as "DiPOLE", it has been developed to be an intrinsically scalable system, providing a high average power basis for energetic pulse production from Joules to kiloJoules.

14:00 - 14:30 (Invited)

**"Power-scaling of Kerr-lens mode-locked Yb:YAG thin-disk oscillators"**

***Jonathan Brons**, Max-Planck-Institute of Quantum Optics, Garching, Germany*

A geometrical energy scaling concept for Kerr-lens mode-locked thin-disk oscillators is presented. With an Yb:YAG thin-disk 14.4 µJ, 330 fs pulses at 18.8 MHz repetition-rate are measured. These 270 W average power and 38 MW peak power are the highest of any mode-locked thin-disk oscillator, operated in air.

## Thursday 28 August 2014

### Novel Fiber Amplifiers - 08:00 - 10:00

08:00 - 08:45 (Keynote)

**"Performance Scaling of Ultrafast Fiber Laser Systems"**

***Jens Limpert**, Friedrich-Schiller-Universität Jena, Jena, Germany*

The presentation will review challenges and achievements of ultrashort pulse amplification in rare-earth-doped fibers as well as the basics of the concept "coherent addition of pulsed laser radiation" and its use for performance scaling. Finally, a design is presented which targets Joule-class femtosecond pulses at repetition rates beyond 10kHz.

08:45 - 09:15 (Invited)

**"Ultrashort-pulse Enhancement Cavities and Applications"**

***Ioachim Pupeza**, Max-Planck-Institut für Quantenoptik, Garching and Ludwig-Maximilians-Universität München, München, Germany*

We review the challenges and the newest developments in scaling the performance of ultrashort-pulse enhancement cavities. Using state-of-the-art Yb:fiber lasers, custom mirrors and cavity designs, we demonstrate at 78-MHz repetition rate 1.9-kW average-power 40-fs pulses and, at 250 MHz, 400 kW with 250-fs pulses and 670 kW with 10-ps pulses.

### Crystalline-host Lasers - 16:45 - 18:45

16:45 -17:15 (Invited)

**"Micro Domain-controlled Laser Materials Toward Giant Micro-photonics"**

***Takunori Taira**, Laser Research Center for Molecular Science, Institute for Molecular Science, Okazaki, Japan*

The past decade has witnessed a veritable revolution in the types and performance levels of solid-state lasers, largely due to development of micro-domain engineered new optical materials: micro-domain structured transparent laser ceramics and ferroelectrics for quasi-phase matched nonlinear optics. We'd like to discuss the capabilities of Giant Micro-photonics for energy.

## Friday 29 August 2014

### Fiber Sources for High-field Experiments - 08:00 - 10:00

08:00 - 08:30 (Invited)

**"Extreme Nonlinear Optics with Kagome Hollow-core PCF"**

***Fetah Benabid**, University of Limoges, Xlim Research Institute, CNRS UMR 7252, GPPMM Group, Limoges, France*

We review the recent progress on hypocycloid-shaped core-contour (*i.e.* negative curvature) hollow-core photonic-crystal-fibre and its implementation for the first time in the fields of micro-wave plasma, whereby a highly stable fibre-confined argon plasma column is generated, and of high optical-fields, where a femtosecond pulse was self-compressed to the sub-cycle cycle regime.

## SUNDAY SESSIONS

### Aula des Jeunes-Rives

**SS1-Summer School "Introduction to the Physics of XUV and X-ray Free-Electron Lasers" - 14:00 - 16:00**

***Jörg Rossbach**, Hamburg University and DESY, Hamburg, Germany*

### Cafeteria

**Coffee break - 16:00 - 16:30**

### Aula des Jeunes-Rives

**SS2 - Summer School "Microresonator Based Optical Frequency Combs" - 16:30 - 18:30**

***Tobias Kippenberg**, Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland*

## MONDAY SESSIONS

### Aula des Jeunes-Rives

**SS3 - Summer School "Continuous-wave Lasers: Theory and Implementation in Rare-earth-doped Waveguides" - 08:00 - 10:00**

***Markus Pollnau**, University of Twente, MESA+ Institute for Nanotechnology, Enschede, The Netherlands*

### Cafeteria

**Coffee Break - 10:00 - 10:30**

### Aula des Jeunes-Rives

**SS4 - Summer School "Applications of Diamond to Solid-state Laser Engineering" - 10:30 - 12:30**

***Alan Kemp**, Fraunhofer UK, University of Strathclyde, Institute of Photonics, Glasgow, United Kingdom*

### Lunch

**Lunch Break - 12:30 - 13:30**

### Aula des Jeunes-Rives

**SS5 - Summer School "Physics of Guided-wave Light Propagation: Applications to Fiber Lasers and Nonlinear Optics" - 13:30 - 15:30**

***Siddharth Ramachandran**, Boston University, ECE Department, Photonics Center, Boston, MA, USA*

### Cafeteria

**Coffee Break - 15:30 - 16:00**

### Aula des Jeunes-Rives

**SS6 - Summer School "An Introduction to Structured Light and its Applications" - 16:00 - 18:00**

***Miles Padgett**, School of Physics and Astronomy, Optics group, University of Glasgow, United Kingdom*

### Walk

**Walk to Castle - 18:15 - 18:30**

### Castle

**Welcome Reception and Invited Talk - 18:30 - 20:45 Solid-State Lasers**

MoA-T1-I-01 (Invited) 18:30

**History of the Discovery of the Stimulated Raman Effect at the Hughes Research Laboratories**

***Gisela Eckhardt**, Hughes Research Labs, Malibu, United Kingdom*

Prof. Gisela Eckhardt will present a talk on "History of the Discovery of the Stimulated Raman Effect at the Hughes Research Laboratories"

## TUESDAY SESSIONS

### Aula des Jeunes-Rives

**OPCPA and Pump Systems - 08:15 - 10:15 Solid-State Lasers**

***Chaired by: Eric Cormier**, University of Bordeaux, Bordeaux, France*

TuA-T1-I-01 (Invited) 08:15

**Frequency domain Optical Parametric Amplification of nJ laser pulses**

***Francois Legare*[1], *Philippe Lassonde*[1], *Maxime Boivin*[1], *Ladan Arissian*[2], *Bruno Schmidt*[1, 3]**

[1] *INRS, Varennes, Canada*

[2] *University of New Mexico, Albuquerque, United States*

[3] *few-cycle Inc., Montreal, Canada*

Using Frequency domain Optical Parametric Amplification, 800nm nJ level pulses are amplified 2.000 to 12.000 times in a single 2mm BBO crystal, pumped by picosecond 400nm pulses. Blocking the seed input yielded a 1400 times weaker superfluorescence level.

TuA-T1-O-02 08:45

**Few-Cycle Mid-Infrared Pulses From Achromatic QPM OPCPA**

***Benedikt W. Mayer*[1], *Christopher R. Phillips*[1], *Lukas Gallmann*[1, 2], *Ursula Keller*[1]**

[1] *Department of Physics, Institute for Quantum Electronics, ETH Zurich, Zurich, Switzerland*

[2] *Institute of Applied Physics, University of Bern, Bern, Switzerland*

We present a quasi-phase matched optical parametric chirped-pulse amplifier (OPCPA) delivering 21.8-µJ, 44.2-fs pulses at a center wavelength of 3.4 µm. The average power corresponds to 1.09 W at 50 kHz repetition-rate. The technique of achromatic quasi-phase-matching is demonstrated in the context of non-collinear OPCPA for the first time.

TuA-T1-O-03 09:00

**Tm:YAP Pumped Intracavity Pulsed OPO Based on Orientation-Patterned Gallium Arsenide (OP-GaAs)**

***Daniel Kane*[1, 2], *John-Mark Hopkins*[2], *Malcolm Dunn*[3], *Peter Schunemann*[4], *David Stothard*[2]**

[1] *Institute of Photonics, University of Strathclyde, Glasgow, United Kingdom*

[2] *Fraunhofer Centre for Applied Photonics, Glasgow, United Kingdom*

[3] *J. F. Allen Physics Research Laboratories, School of Physics & Astronomy, University of St. Andrews, St. Andrews, United Kingdom*

[4] *BAE Systems Inc., Nashua, United States*

We describe the operation of a long wavelength singly resonant optical parametric oscillator (OPO) based upon the nonlinear material orientation-patterned gallium arsenide (OP-GaAs) pumped internal to a high repetition rate, Q-switched Tm:YAP laser. This device is a low cost, compact and efficient, broadly tunable mid-IR spectroscopic platform.

TuA-T1-O-04 09:15

**CPA-free solid-state amplifier for sequential pump depletion in a 10 µJ multi-pass OPCPA system at 100 kHz**

***Jan Matyschok*[1, 2], *Oliver Prochnow*[2], *Thomas Binhammer*[2], *Tino Lang*[1, 3], *Stefan Rausch*[2], *Bastian Schulz*[4], *Maik Frede*[4], *Uwe Morgner*[1, 3, 5]**

MAIN CONFERENCE

[1] Institut of Quantum Optics, Leibniz Universität Hannover, Hannover, Germany
[2] VENTEON Laser Technologies GmbH, Garbsen, Germany
[3] Centre for Quantum Engineering and Space-Time Research (QUEST), Hannover, Germany
[4] neoLASE GmbH, Hannover, Germany
[5] Laser Zentrum Hannover e.V, Hannover, Germany

We present a compact multi-stage OPCPA system, pumped by an optical synchronized frequency doubled CPA-free solid-state amplifier at 100 kHz. Broadband parametric amplification in two double pass NOPA stages pumped at 532 nm, leading to 10 µJ of pulse energy with pulse durations below 15 fs.

TuA-T1-O-05 09:30

**High energy, high repetition rate pump laser system for OPCPAs**

***Anne-Laure Calendron*[1, 2], *Luis E. Zapata*[1], *Huseyin Cankaya*[1, 2], *Hua Lin*[3], *Franz X. Kärtner*[1, 2, 3]**
[1] Center for Free-Electron Laser Science, Deutsches Elektronen Synchrotron, and Department of Physics, University of Hamburg, Hamburg, Germany
[2] The Hamburg Centre for Ultrafast Imaging, Hamburg, Germany
[3] Department of Electrical Engineering and Computer Science and Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, United States

A high-energy, 1-kHz pump laser system for combined white-light generation and OPCPA pumping is demonstrated. The 6.5-mJ output pulses from an Yb:KYW regenerative amplifier are partially compressed to 700fs for CEP stable white-light generation, and partially further amplified in a cryogenically cooled amplifier to 31.2mJ before compression for OPCPA pumping.

TuA-T1-O-06 09:45

**DiPOLE: A 10 J, 10 Hz multi-slab cryogenic gas cooled Yb:YAG amplifier**

***Saumyabrata Banerjee, Klaus Ertel, Paul Mason, Jonathan Phillips, Jodie M. Smith, Maria Stefania De Vido, Thomas Butcher, David Richards, Justin Greenhalgh, Cristina Hernandez - Gomez, John Collier***
*Central Laser Facility, STFC Rutherford Appleton Laboratory, Chilton, Didcot OX11 0QX, UK, Didcot, United Kingdom*

We report the recent results obtained from the DiPOLE amplifier for 10 Hz operation, this includes the first demonstration of 10 J output corresponding to an optical-to-optical conversion efficiency of 21%. We demonstrate 48Hr operation at 7J output and second harmonic generation (SHG) at 10Hz utilising DKDP, YCOB and LBO crystals.

TuA-T1-O-07 10:00

**Neodymium Glass Laser with a Phase Conjugate Mirror Generating Several Hundred Joules Pulses in 1 Shot per 1 Minute Regime**

***Alexey Kuzmin, Efim Khazanov, Andrey Shaykin***
*Institute of Applied Physics of the Russian Academy of Sciences, 46 Ulyanov Street , 603950, Nizhny Novgorod, Russia, Nizhny Novgorod, Russia*

For pumping multipetawatt Ti:sapphire laser facility we developed a compact Nd:glass laser generating 220J, 30ns FWHM pulses with repetition rate of 0.02Hz. The beam fill factor was 0.8. Phase distortions of laser radiation were compensated by optical phase conjugation. The depolarization was reduced to 0.4%. The beam divergence was 150µrad.

## Cafeteria

**Coffee Break - 10:15 - 10:45**

## Aula des Jeunes-Rives

**Novel Pulsed Fiber Sources - 10:45 - 12:45**
**Fibre and Waveguide Devices**

***Chaired by: F. Ömer Ilday**, Bilkent University, Ankara, Turkey*

TuB-T2-I-01 (Invited) 10:45

**Recent Advances in Mid-Infrared Fiber Lasers**

***Martin Bernier, Vincent Fortin, Mohammed El - Amraoui, Younès Messaddeq, Réal Vallée***
*COPL, Laval University, Quebec, Canada*

Recent advances in the development of fiber lasers operating in the mid-infrared will be reviewed. A 30W-level erbium-doped fluoride glass fiber laser emitting in the vicinity of 3µm will be detailed. The conversion of such laser in the 3-4µm window by stimulated Raman scattering in chalcogenide fibers will be demonstrated.

TuB-T2-O-02 11:15

**Sub-100 fs Passively Mode-Locked Holmium-Fibre Oscillator Operating at 2.06 µm**

***Peng Li, Axel Ruehl, Ingmar Hartl***
*Desutsches Elektronen-Synchrotron (DESY), Hambburg, Germany*

We demonstrate a compact passively mode-locked Holmium-fibre oscillator delivering 160 fs pulses at 1 nJ pulse energy. With a nonlinear fibre-compressor the pulses could be shortened to below 100 fs. This constitutes a 20-fold improvement in spectral bandwidth and 8-fold improvement in pulse duration compared to previously reported Ho-fibre oscillators.

TuB-T2-O-03 11:30

**Seeded amplification of the Stokes wave in an ultrafast fiber amplifier**

***Uğur Teğin*[1], *Parviz Elahi*[1], *Sinem Yılmaz*[1], *Fatih Ömer İlday*[1, 2]**
[1] Department of Physics Bilkent University, Ankara, Turkey
[2] Department of Electrical and Electronics Engineering, Ankara, Turkey

We report Seeded amplification of the Stokes wave in an ultrafast fiber amplifier. Our setup consists of master oscillator and amplifier. Stokes wave generated during amplification is filtered and feedbacked to amplifier. With this design we achieve to increase the intensity of Stokes waves and generate 2.9ps pulses at 1080nm

TuB-T2-O-04 11:45

**Self-starting all-polarization maintaining Yb-fiber laser with a polarization maintaining anomalous dispersion higher-order-mode fiber**

***Zhu Lingxiao*[1, 2], *Aart Verhoef*[1], *Lars Grüner-Nielsen*[3], *Stine Møller Israelsen*[4], *Andrius Baltuska*[1], *Alma Fernández*[1]**
[1] Photonics Institute, TU Wien, Wien, Austria
[2] University of Vienna, Vienna, Austria
[3] OFS Denmark, Brøndby, Denmark
[4] Technical University of Denmark, Department of Photonics Engineering, Kgs. Lyngby, Denmark

An Yb-fiber oscillator with an all-polarization maintaining cavity with a mode fiber for intracavity dispersion control is presented. Different dispersion regimes will be investigated and characterized. In the weakly stretched pulse regime 1 nJ pulses externally compressible to 150 fs are generated.

TuB-T2-O-05 12:00

**Carrier-envelope phase stable multi-output seed source for OPCPA**

*Armin Zach, Axel Friedenauer, Robert Herda*
*TOPTICA Photonics AG, Graefelfing, Germany*
We present a passively CEO phase-stable femtosecond laser source providing multiple phase coherent outputs for OPCPA applications. Via difference frequency generation between the dispersive and the soliton part of an all-fiber generated super-continuum a broadband spectrum centered at 1560nm is obtained. The resulting CEO phase-stable signal enables generating multiple phase stable outputs.

TuB-T2-O-06 12:15

**Picosecond fiber generator using a self-phase modulation and alternating spectral filtering**

***Kęstutis Regelskis, Julijanas Želudevičius, Gediminas Račiukaitis***
*Department of Laser Technology, Center for Physical Sciences & Technology, Vilnius, Lithuania*
We present a novel scheme of a picosecond fiber generator based on an alternating-double spectral filtering of the pulses amplified and spectrally broadened due to self-phase modulation in a fiber. Pulses with the duration of 2.27 ps were generated experimentally.

TuB-T2-O-07 12:30

**Gain-switched laser diode seeded Yb-doped 73 dB low-noise fiber amplifier delivering 11 picosecond pulses with more than 0.5 MW peak power**

***Manuel Ryser[1], Sönke Pilz[2], Burn Andreas[2], Valerio Romano[1, 2]***
*[1] Institute of Applied Physics, University of Bern, Sidlerstrasse 5, Bern, Switzerland*
*[2] Bern University of Applied Sciences, ALPS, Pestalozzistrasse 20, Burgdorf, Switzerland*
We demonstrated low-noise 73dB all-fiber amplification of 11ps pulses at 1064nm from a gain-switched laserdiode. With a novel time-domain method we determined the signal to noise ratio and the optimal working point of the amplifier. The amplifier achieved >5.6μJ pulse energy and >0.5MW pulse peak power.

## Lunch

**Lunch Break - 12:45 - 13:45**

## Aula des Jeunes-Rives

**Prize for Research in Laser Science and Applications - Ceremony and Lecture - 13:45 - 14:45**

The first Prize for Research in Laser Science and Applications is awarded to Thomas Udem, research associate at Max-Planck-Institut für Quantenoptik, Garching, Germany for "significant contributions to the development of optical frequency combs and their extension into the vacuum-ultra-violet region, as well as the realization of applications in astronomy, metrology and ultra-precise fast sensitive spectroscopy".

## Poster Session RE 42 / RE 46

**Poster Session 1 with Coffee Break 14:45 - 16:15**

Solid-State Lasers / Fibre and Waveguide Devices

A coffee break will take place at the same time (in the cafeteria).

TuP-T2-P-01

**813-nm narrow linewidth light source for Sr optical lattice clock based on Tm-doped fluoride fiber amplifier**

***Yu-ichi Takeuchi[1], Eiji Kajikawa[1], Kenta Kohno[1], Ken'ichi Nakagawa[1], Mitsuru Musha[1, 2]***
*[1] Institute for Laser Science, University of Electro-Communications, Tokyo, Japan*
*[2] Innovative Space-time Project, ERATO, JST, Tokyo, Japan*
We have developed the stable and high power fiber MOPA system at 813 nm for the Sr optical lattice clock. By using the Tm-doped fluoride fiber amplifier, Maximum output power of 1.6 W is obtained whose linewidth is less 200 kHz.

TuP-T2-P-02

**Laser Emission in Diode-Pumped Nd:YAG Cladding Waveguides Fabricated by Direct Writing with a Helical Movement Technique**

***Nicolaie Pavel[1], Gabriela Salamu[1], Florin Jipa[2], Marian Zamfirescu[2], Flavius Voicu[1], Traian Dascalu[1]***
*[1] Laboratory of Solid-State Quantum Electronics, National Institute for Laser, Plasma and Radiation Physics, Bucharest, Romania*
*[2] Solid-State Laser Laboratory, Laser Department, National Institute for Laser, Plasma and Radiation Physics, Bucharest, Romania*
Cladding waveguides were inscribed in Nd:YAG ceramic by a novel technique in which the laser medium is moved on a helical trajectory along its axis and parallel to the writing direction. Efficient laser emission at 1.06 μm and 1.3 μm is obtained under quasi-continuous-wave pumping with a fiber-coupled diode laser.

TuP-T2-P-03

**Synchronization of Er- and Tm-doped fiber mode-locked lasers by a common graphene saturable absorber**

***Jan Tarka[1], J. Sotor[1], Grzegorz Sobon[1], J. Bogusławski[1], K. Krzempek[1], I. Pasternak[2], A. Krajewska[2, 3], W. Strupinski[2], K.M. Abramski[1]***
*[1] Laser & Fiber Electronics Group, Wroclaw University of Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland, Wroclaw, Poland*
*[2] Institute of Electronic Materials Technology, Wolczynska 133, 01-919 Warsaw, Poland, Warsaw, Poland*
*[3] Institute of Optoelectronics, Military University of Technology, Gen. S. Kaliskiego 2, 00-908 Warsaw, Poland, Warsaw, Poland*
We report synchrous ultra-short pulse generation in 1.5 μm and 2 μm spectral ranges using common graphene based saturable absorber. The 915 fs and 1.57 ps soliton pulses were produced in Er-doped and Tm-doped fiber lasers, respectively. Synchronization holding range of reported system were also investigate.

TuP-T2-P-04

**High-power actively mode-locked Tm3+-doped silica fiber laser**

***Christian Kneis[1], Antoine Berrou[1], Inka Manek-Hönninger[2], Marc Eichhorn[1], Christelle Kieleck[1]***
*[1] French-German Research Institute of Saint-Louis, ISL, 5 rue du Général Cassagnou, 68301 Saint Louis, FR, Saint Louis, France*
*[2] Laboratoire Ondes et Matière d'Aquitaine, Université Bordeaux 1, 351 cours de la Libération, 33405 Talence, FR, Talence, France*
A diode-pumped actively mode-locked $Tm^{3+}$-doped double-clad silica fiber laser providing up to 30 W of average output power and 300 ps pulse width in mode-locked operation is reported. The fiber laser is harmonically mode-locked at a repetition rate of 66 MHz and produces a pulse energy of 454 nJ.

TuP-T2-P-05

**Graphene Q-switched Yb:Phosphate Glass Channel Waveguide Laser**

***Amol Choudhary[1], Shonali Dhingra[2], Brian D'Urso[2], Pradeesh Kannan[1], David Shepherd[1]***
*[1] Optoelectronics Research Centre, University of Southampton, Southampton, United Kingdom*

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[2] Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, United States
An ion-exchanged Yb-doped phospate glass channel waveguide laser is Q-switched using atmospheric-pressure-chemical-vapour-deposition-grown (APCVD) graphene as a saturable absorber. 140 ns pulses are generated at a repetition rate of 781 kHz and a pulse energy of 27 nJ at a wavelength of 1055 nm.

TuP-T2-P-06

**The Impact of Core Displacement on Optical Properties of PCFs**

***Vladimir Demidov, Victor Shevandin***
*S.I. Vavilov State Optical Institute, St. Petersburg, Russia*
We analyze both theoretically and experimentally the modal and leakage properties of large mode area photonic crystal fibers with the core displaced from the center of the lattice. The core displacement factor has the great impact on the fiber mode area scaling potential and spectral operation range expansion.

TuP-T2-P-07

**Fabrication of long-period fiber-gratings by exposure to low-pressure mercury lamp - Effect of hydrogen loading**

***Toru Mizunami, Yoshihisa Tashiro***
*Graduate School of Engineering, Kyushu Institute of Technology, Kitakyushu, Japan*
Low-cost fabrication of long-period gratings using exposure to a low-pressure mercury lamp was studied. By increasing the gas pressure in hydrogen loading from 120 to 135 atm, shortening of the exposure time to 2/3 was achieved. Further shortening was achieved for a longer loading time. Temperature and strain sensitivities were measured.

TuP-T2-P-08

**High Peak Power Femtosecond Dissipative Dispersion-managed Soliton Generation in Mode-locked Thulium Doped Fiber Laser**

***Fangzhou Tan, Jiang Liu, Kun Liu, Shoufei Gao, Pu Wang***
*Institute of Laser Engineering, Beijing University of Technology, Beijing, China*
We report an dispersion managed mode-locked thulium doped fiber laser. The laser delivered up chirped pulses with 0.19 nJ pulse energy. The pulse can be compressed to 285 fs after one-stage single-mode thulium doped fiber amplifier. The output power is 150 mW corresponding to a peak power of 40 kW.

TuP-T2-P-09

**Dissipative soliton resonance by reverse saturable absorption in graphene oxide mode-locked All-normal-dispersion Yb-doped fiber laser**

***Zhaochen Cheng, Huihui Li, Hongxing Shi, Pu Wang***
*Institute of Laser Engineering, Beijing University of Technology, Beijing, China*
We have observed dissipative soliton resonance phenomenon in our mode-locked Yb-doped fiber laser with graphene oxide as saturable absorber. Reverse saturable absorption, which comes from the etalon effect by a pair of non-touch fiber connectors in normal dispersion, plays a big role in generating square shaped pulses.

TuP-T1-P-10

**Fiber mode-locked lasers based on topological insulator saturable absorbers**

***Jaroslaw Sotor, Grzegorz Sobon, Jakub Boguslawski, Jan Tarka, Karol Krzempek, Krzysztof Abramski***
*Laser & Fiber Electronics Group, Wroclaw University of Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland, Wroclaw, Poland*
We present the fiber mode-locked lasers based on evanescent filed interaction with antimony telluride topological insulator. The saturable absorber allows for mode-locked operation in all-anomalous, all-normal and stretched pulse dispersion regimes. The work presents the shortest pulses (128 fs) so far generated in topological insulator based resonators.

TuP-T1-P-11

**High-power, kHz-repetition rate femtosecond Fiber-CPA system at 1.55 µm**

***Grzegorz Sobon, Jaroslaw Sotor, Dorota Sliwinska, Aleksander Gluszek, Karol Krzempek, Pawel Kaczmarek, Krzysztof Abramski***
*Wroclaw University of Technology, Wroclaw, Poland*
In this work, we demonstrate a high-power fiber-based CPA setup utilizing Er- and Er/Yb-doped fibers, operating at the 1554 nm wavelength. The integrated pulse-picker allows to reduce the repetition frequency up to the kHz-range, which enables generation of 900 fs pulses with energies at the level of 0.75 µJ.

TuP-T1-P-12

**LD-seeded thulium-doped fibre amplifier for $CO_2$ measurements at 2 µm**

***Yutong Feng[1], Johan Nilsson[1], Saurabh Jain[1], Timothy May-Smith[1], Jayanta Sahu[1], Fuqiang Jia[1], David Wilson[2], Michael Lengden[2], Walter Johnstone[2]***
*[1] Optoelectronics Research Centre, University of Southampton, Southampton, United Kingdom*
*[2] Centre for Microsystems and Photonics, Dept. Electronic and Electrical Engineering, University of Strathclyde, Glasgow, United Kingdom*
A simple single-stage thulium-doped fibre amplifier reaches 2.5 W of output power while simultaneously suppressing unwanted power modulation when seeded by a DFB laser-diode, wavelength-modulated around 1997 nm. The system meets the requirements for chemical species tomography of $CO_2$ in aero-engine exhaust plumes with desired spatial and temporal resolution.

TuP-T1-P-13

**Metal-Coated Large-Core Single-Mode Microstructured Fiber**

***Aleksandra Pasishnik, Victor Shevandin***
*S.I. Vavilov Federal Optical Institute, St. Petersburg, Russia*
We have fabricated and investigated metal-coated large-core single-mode microstructured fibers. It was found from the theoretical analysis that the better uniformity of coating could be obtained if the constructional cladding thickness ranges from 60 µm to 90 µm. Investigated samples passed proof-test with 1%-elongation.

TuP-T1-P-14

**10 cm length Efficient Rod-Type Photonic Crystal Fiber Laser**

***Boris Rosenstein[1], Avry Shirakov[1, 2], Daniel Belker[1], Amiel A. Ishaaya[1]***
*[1] Department of Electrical and Computer Engineering, Ben-Gurion University of the Negev, Beer-Sheva, Israel*
*[2] Department of Physics, Ben-Gurion University of the Negev, Beer-Sheva, Israel*
We experimentally demonstrate and investigate extremely short cavity photonic crystal fiber laser. With our special pump design, we succeeded to demonstrate doubled pump absorption, and corresponding improvement of lasing performance, compared with standard pumping schemes.

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TuP-T1-P-15

**Single transverse mode and high-average-power operation in tapered double-clad Yb-doped multimode fiber.**

***Hidetsugu Yoshida, Koji Tsubakimoto, Hisanori Fujita, Noriaki Miyanaga***

*Institute of Laser Engineering, Osaka University, Suita, Osaka, Japan*

We have achieved high-average-power and single transverse mode operation from tapered double-clad Yb-doped multimode fiber (TDC-YDF) amplifier. The near-field pattern of the TDC-YDF amplified pulse had good Gaussian profile. The beam quality M2 was 1.2-1.3 at 10 W output power and1.6-1.8 at 36 W output level.

TuP-T1-P-16

**Measurement of the Polarization Mode Dispersion in a HC-800 Photonic Crystal Fiber**

***Tímea Grósz[1], Katalin Csonti[1], Róbert Szipőcs[2], Attila Pál Kovács[1]***

*[1] Department of Optics and Quantum Electronics, University of Szeged, Dóm tér 9, H-6720 Szeged, Hungary, Szeged, Hungary*

*[2] Institute for Solid State Physics and Optics, Wigner RCP, Konkoly Thege út 29-33, H-1121 Budapest, Hungary, Budapest, Hungary*

The dispersion properties of a HC-800 photonic crystal fiber in different placements were investigated. It was demonstrated that the fiber had birefringence despite its hollow-core and symmetrical geometry. Furthermore, it was proven that the dispersion is mainly independent on the placement and that it is additive.

TuP-T1-P-17

**Compression of Chirp Pulses from a Femtosecond Fiber Based Amplifier**

***Rumi Ito[1], Kazuyoku Tei[1], Shigeru Yamaguchi[1], Jun Enokidani[2], Shin Sumida[2]***

*[1] Tokai University, Hiratsuka, Japan*

*[2] OPT-i Co.,Ltd., Kashiwa, Japan*

We demonstrate the chirp pulse generation with an all fiber master oscillator power amplifier. We use a passive mode-locked Yb doped fiber laser with a 180 fs pulse width at a 42 MHz repetition rate for the master oscillator. The spectral width of amplified pulses was 18 nm.

TuP-T1-P-18

**$\chi^{(2)}$-lens mode-locking of a Nd:YVO4 laser with high average power and repetition rate up to 600 MHz**

***Veselin Aleksandrov[1], Teodora Grigorova[1], Hristo Iliev[2], Ivan Buchvarov[1]***

*[1] Physics Department, Sofia University, Sofia, Bulgaria*

*[2] Binovation Ltd., Sofia, Bulgaria*

$\chi^{(2)}$-lens mode-locking is applied to a diode-pumped Nd:$YVO_4$ laser for generation of 6.1 ps pulses with 6.1 W average power at repetition rate up to 600 MHz. The $\chi(2)$-nonlinear process introduces negative intracavity self-phase modulation corresponding to soliton pulse formation.

TuP-T1-P-19

**Nested Cavity Optical Parametric Oscillator Emitting at 8 µm Pumped by a Pulsed Single-Frequency 2 µm Fiber Laser**

***Quentin Clément[1], Erik Lucas[1, 2], Jean-Michel Melkonian[1], Jean-Baptiste Dherbecourt[1], Myriam Raybaut[1], Guillaume Canat[1], Antoine Godard[1]***

*[1] ONERA the French Aerospace Lab, Palaiseau, France*

*[2] Keopsys, Lannion, France*

We report an optical parametric oscillator in a nested cavity configuration (NesCOPO) with a ZnGeP2 crystal, pumped by a pulsed 2 µm fiber laser and emitting around 8 µm. Since the first characterizations of the NesCOPO have been made, the main objective is to obtain a single-frequency tunable radiation.

TuP-T1-P-20

**Yb:$CaF_2$: thermal effects in diode pumped high power multipass amplifiers**

***Dimitris N. Papadopoulos[2], Patrice Camy[3], Jean-Louis Doualan[3], Richard Moncorgé[3], Patrick Georges[1], Frédéric Druon[1], Florence Friebel[1]***

*[1] Laboratoire Charles Fabry, Institut d'Optique, CNRS, Univ Paris Sud 11, 2 Av. A. Fresnel, 91127 Palaiseau Cedex, France, Palaiseau, France*

*[2] Laboratoire d'Utilisation des Lasers Intenses,CNRS,Ecole Polytechnique,CEA,Univ P. et M. Curie,Palaiseau,France, Palaiseau, France*

*[3] Centre de Recherche sur les Ions,les Matériaux et la Photonique,CNRS,CEA,ENSI Caen,Université de Caen,France, Caen, France*

The dynamic thermal issues of the Yb:-$CaF_2$-crystals within a multi-mJ-energy multipass amplifier operating around 20-100 Hz, pumped in quasi-cw regime have been studied at different time scales. This complete analysis is used to demonstrate operating the amplifier at 20 Hz with 57 mJ and 100 Hz with 39-mJ stable regime.

TuP-T1-P-21

**Deep ultraviolet vortex generation based on nonlinear frequency conversion by periodically-bonded β-$Ba_2B_2O_4$ device**

***Yuta Sasaki[1], Katsuhiko Miyamoto[1], Ichiro Shoji[2], Takashige Omatsu[1, 3]***

*[1] Chiba University, 1-33 Yayoi-cho, Inage-ku, Chib, Japan*

*[2] Chuo University, 1-13-27 Kasuga, Bunkyo-ku Toky, Japan*

*[3] CREST Japan Science and Technology Agency, Sanbancho, Chiyoda-ku, Tokyo,, Japan*

We demonstrate a DUV (266nm) vortex generation by utilizing a periodically-bonded β-$BaB_2O_4$ (BBO) device formed of four 0.5mm BBO crystals with alternating orientations, so as to cancel out the walk-out effect. Experimental DUV nanosecond vortex pulse energy of 1.24 mJ was obtained, corresponding to a conversion efficiency of 13.7%.

TuP-T1-P-22

**Efficient Sub-Nanosecond Pulse Generation at 1180 nm and 559 nm with a $SrWO_4$ Raman Crystal Pumped by a Multi-kHz MOPA Laser System**

***Paolo Farinello[1], Federico Pirzio[1], Yuangeng Zhang[2, 3], Antonio Agnesi[1], Valentin Petrov[3]***

*[1] Dipartimento di Ingegneria Industriale e dell'Informazione, Università di Pavia, via Ferrata 5, IT-27100 Pavia, Italy, Pavia, Italy*

*[2] School of Information Science and Engineering and Shandong Provincial Key Laboratory of Laser Technology and Application, Shandong University, 250100 Jinan, China, Jinan, China*

*[3] Max-Born-Institute for Nonlinear Optics and Ultrafast Spectroscopy, 2A Max-Born-Str., D-12489 Berlin, Germany, Berlin, Germany*

We investigated stimulated Raman scattering in near-infrared and visible employing a $SrWO_4$ crystal pumped by ~150-µJ, 500-ps pulses at multi-kHz repetition rate. Conversion slope efficiencies exceeded 40% (25 and 56-µJ maximum pulse energies at 1190 and 559-nm respectively). Pulse compression and good beam quality (M2<1.5) were demonstrated.

TuP-T1-P-23

**Passive linewidth reduction of the carrier-envelope-offset frequency through high-brightness pumping**

***Sandro Link[1], Alexander Klenner[1], Mario Mangold[1], Christian Zaugg[1], Aline Mayer[1], Emilio Gini[2], Bauke Tilma[1], Ursula Keller[1]***

MAIN CONFERENCE

[1] Institute for Quantum Electronics, ETH Zürich, Zürich, Switzerland
[2] FIRST Center for Micro- and Nanoscience, ETH Zürich, Zürich, Switzerland
We present, for the first time, a direct comparison of the free-running $f_{CEO}$ linewidth using multi-transversal-mode pumping with and without a brightness converter. High brightness pumping results in a strongly reduced $f_{CEO}$ linewidth and reduced amplitude noise at higher frequencies. This pumping scheme will allow for stabilized gigahertz frequency combs

TuP-T1-P-24

**Spectrally-tailored thulium-doped fibre amplified spontaneous emission source at two-microns**

***Antonin Billaud, Peter Shardlow, Jae Daniel, Andy Clarkson***
*Optoelectronics Research Centre, University of Southampton, Southampton, United Kingdom*
A thulium-doped fibre source with a novel resonator architecture that produces amplified spontaneous emission output with spectral shape that be tailored in an arbitrary manner is reported. The source yielded 6W of single-mode output in the two-micron band for 18W of pump power at 1565nm with spectral resolution of 0.5nm.

TuP-T1-P-25

**Noise Analysis of Ho:YLF and Ho:YAG Regenerative Amplifiers**

***Peter Kroetz[1], R.J. Dwayne Miller[1], Axel Ruehl[2], Ingmar Hartl[2]***
*[1] Max-Planck Institute for the Structure and Dynamics of Matter, Hamburg, Germany*
*[2] Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany*
We present a numerical noise analysis of high-energy, high-gain regenerative amplifiers based on Ho:YLF and Ho:YAG crystals. The systems were modelled including pump and seed noise. For similar performance in a comparable setup, we demonstrate that Ho:YLF exhibits more than five times lower output noise.

TuP-T1-P-26

**Pulse-To-Pulse Spectra of a Picosecond Optical Parametric Oscillator Based on Chirped Quasi-Phase Matching**

***Delphine Descloux[1], Cédric Laporte[1], Jean-Baptiste Dherbecourt[1], Jean-Michel Melkonian[1], Myriam Raybaut[1], Cyril Drag[2], Antoine Godard[1]***
*[1] ONERA–The French Aerospace Lab, Palaiseau, France*
*[2] Laboratoire Aimé-Cotton, CNRS-Université Paris Sud 11, ENS Cachan, Orsay, France*
The pulse-to-pulse evolution of the spectrum emitted by a picoseconds synchronously-pumped optical parametric oscillator based on chirped quasi-phase matching is measured, enabling to study the spectro-temporal dynamics upon the buildup of the oscillation

TuP-T1-P-27

**Holmium-doped KYW conical refraction laser emitting at 2 µm**

***Romain Cattoor[1, 2], Inka Manek-Hönninger[2], Daniel Rytz[3], Lionel Canioni[2], Marc Eichhorn[1]***
*[1] Institut Franco-Allemand de recherches de Saint-Louis, Saint-Louis, France*
*[2] Laboratoire Ondes et Matière d'Aquitaine (LOMA-CNRS-UMR 5798), Talence, France*
*[3] FEE GmbH, Idar-Oberstein, Germany*
We present a quasi-three-level Conical Refraction (CR) laser using a Holmium doped KYW crystal. Up to 1.5W of output power was obtained. The lasing threshold and slope efficiency of the CR laser are compared with a classical "Gaussian" laser operating near the optic axis.

TuP-T1-P-28

**Piezoelectric Resonance Laser Calorimetry for Precise Measurement of Crystal Optical Absorption**

***Aleksey Konyashkin[1, 2, 3], Oleg Ryabushkin[1, 2, 3]***
*[1] NTO «IRE-Polus», Fryazino, Russia*
*[2] Moscow Institute of Physics and Technology, Dolgoprudnyy, Russia*
*[3] Kotelnikov Institute of Radio-engineering and Electronics of RAS, Fryazino, Russia*
Impedance spectroscopy technique is implemented for measurement of piezoelectric crystal temperature during its interaction with laser radiation. Optical absorption and heat transfer coefficients of crystal can be measured in calorimetry experiment using crystal piezoelectric resonance frequency temperature dependence.

TuP-T1-P-29

**Spectroscopy and 900-nm Laser Operation of Nd,Mg-doped $SrAl_{12}O_{19}$**

***Daniel-Timo Marzahl[1], Liang Gong[1], Thomas Calmano[1, 2], Fabian Reichert[1], Christian Kränkel[1, 2], Günter Huber[1, 2]***
*[1] Institut für Laser-Physik, Universität Hamburg, Hamburg, Germany*
*[2] The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Hamburg, Germany*
We report on spectroscopy and laser operation of Nd,Mg:$SrAl_{12}O_{19}$. The laser operated in the three-level-scheme at 899.8nm with a maximum output power of 297mW and a slope efficiency of 23% under ti:sapphire pumping at 798.2nm.

TuP-T1-P-30

**An Evaluation of Nd:$YVO_4$ as a Gain Material for Low-Complexity Disk-Based Picosecond Amplifiers**

***Ewan Bennett[1, 2], Gerald Bonner[1], Alan Kemp[2], David Stothard[1], John-Mark Hopkins[1]***
*[1] Fraunhofer Centre for Applied Photonics, Glasgow, United Kingdom*
*[2] Institute of Photonics, Glasgow, United Kingdom*
The high absorption and emission cross-sections of Nd:$YVO_4$ offer a potential route to high power, low-complexity thin-disk amplifiers with good beam quality for ultrafast micromachining. With a combination of modelling and experimental investigation, a system based on a picosecond seed laser with 30 W average power is assessed.

TuP-T1-P-31

**Progress in Chemical Synthesis and Crystal Growth of Irradiation Free Low Absorption $ZnGeP_2$ for Infrared Nonlinear Conversion**

***Johan Petit[1], Jérémy Rame[1], Quentin Clément[2], Jean-Michel Melkonian[2], Myriam Raybaut[2], Jean-Baptiste Dherbecourt[2], Antoine Godard[2], Olivier Muller[3], Anne Hildenbrand[3], Christelle Kieleck[3], A. Berrou[3], F. Moitrier[3], M. Eichhorn[3]***
*[1] ONERA - The French Aerospace Lab, Châtillon, France*
*[2] ONERA - The French Aerospace Lab, Palaiseau, France*
*[3] ISL French-German Research Institute of Saint-Louis, Saint-Louis, France*
We present our recent progress in the synthesis, growth and post-treatment of low-absorption $ZnGeP_2$. The current residual absorption level at 2 µm is of 0.15 cm-1 without resorting to electron irradiation. We also present our first results on nonlinear frequency conversion and related laser-induced damage threshold measurements.

TuP-T1-P-32

**Temperature influence on diode pumped Dy:PGS laser**

***Michal Němec[1], Jan Šulc[1], Maxim Doroshenko[2],***

MAIN CONFERENCE

*Martin Fibrich[1], Helena Jelínková[1], Pavel Fedorov[2], Vjatcheslav Osiko[2]*
*[1] Czech Technical University in Prague, Prague, Czech Republic*
*[2] Russian Academy of Sciences, Moscow, Russia*
The active medium temperature influence on diode-pumped Dy:$PbGa_2S_4$ laser, operating at 4.3 μm spectral region, was investigated. Diminution of the laser threshold more than 7-times and emission wavelength shift about 60 nm corresponded to temperature decrease from 300 K to 80 K.

TuP-T1-P-33

**Plasma-driven instability in solids subject to stimulated Brillouin scattering and Kerr filamentation**

*Jérémie Rolle, Luc Bérgé, Christian Kohler*
*. CEA, DAM, DIF, Arpajon, France*
The interplay between Brillouin scattering and Kerr self-focusing in silica is numerically investigated. Nanosecond filaments in solids are shown to trigger plasma generation, which initiates modulational instability near the entrance face of the material due to strong backscattering. Phase modulations are used to inhibit backscattered waves together with plasma-driven instabilities.

TuP-T1-P-34

**Thermo-optic characterization of Yb:$YAl_3(BO_3)_4$ laser crystal**

*Pavel Loiko[1], Valery Filippov[2], Nikolai Kuleshov[1], Nikolai Leonuyk[3], Viktor Maltsev[3], Konstantin Yumashev[1]*
*[1] Center for Optical Materials and Technologies, Belarusian National Technical University, Minsk, Belarus*
*[2] B.I. Stepanov Institute of Physics, National Academy of Sciences of Belarus, Minsk, Belarus*
*[3] Faculty of Geology, Moscow State University, Moscow, Russia*
Thermo-optic coefficients are measured for Yb:$YAl_3(BO_3)_4$ laser crystal by a modified minimum deviation method, and thermo-optic dispersion formulas are presented. The optical power of thermal lens is determined for principal crystal cuts (a or c-cut), as well as laser polarizations (π or σ).

TuP-T1-P-35

**Comparison of Fe:ZnSe and Fe:ZnMgSe laser characteristics in dependence on temperature**

*Maxim E. Doroshenko[1], Helena Jelinkova[2], Michal Nemec[2], Jan Suilc[2], Michal Jelinek[2], Yurij A. Zagoruiko[3], Nazar O. Kovalenko[3], Andrey S. Gerasimenko[3], Vyacheslav M. Puzikov[3], Vitaly K. Komar[3]*
*[1] A. M. Prokhorov General Physics Institute, Russian Academy of Sciences, Laser Materials and Technology Research Center, Vavilov Str. 38, Moscow, Russia*
*[2] Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering Brehová 7, Prague 1, Czech Republic*
*[3] Institute for Single Crystals, NAS of Ukraine, 60 Lenin Ave., Kharkiv, Ukraine*
Temperature dependence of spectroscopic and laser properties of bulk Bridgman-grown Fe:ZnSe and Fe:Zn1-xMgxSe single crystals with two various Mg concentrations x were investigated. The emission wavelength shift from 4100 nm for Fe:ZnSe up to 4800 nm for Fe:Zn1-xMgxSe (x=0.38) at 88 K was obtained.

TuP-T1-P-36

**Circular polarized second harmonic generation in single-layered gold sawtooth structures**

*Yuxiang Guo, Huimin Su, Wensheng Gao, Wing Yim Tam, Che Ting Chan, Kam Sing Wong*
*Department of Physics, The Hong Kong University of Science and Technology, Kowloon, Hong Kong*
We report on the study of circular polarized second harmonic generation of single-layered gold sawtooth gratings consisting of И and N basic unit incident by left hand and right hand circular polarized light. The result shows that the chiral properties of the structure lead to the chiral nonlinear optical properties.

TuP-T1-P-37

**Investigation on Crystal Geometry for a Continuous-Wave High-Power 1.6 μm $Er^{3+}$:YAG Laser**

*Marie Blattmann[1, 2], Thierry Ibach[1], Stefano Bigotta[1], Bruno Serio[3], Pierre Pfeiffer[2], Marc Eichhorn[1]*
*[1] French-German Research Institute of Saint-Louis (ISL), Saint-Louis, France*
*[2] Laboratoire ICube, Université de Strasbourg, Illkirch-Graffenstaden, France*
*[3] Laboratoire Energétique Mécanique Electromagnétisme (LEME), Ville d'Avray, France*
We present a design study on laser crystal geometry for an "eye-safe" 1.6μm erbium laser based on Zigzag-slab architecture. To improve laser efficiency, the slab geometry is optimized by simultaneously taking into account detrimental effects like undesirable thermal issues, pump distribution inhomogeneity and parasitic lasing

## Aula des Jeunes-Rives

**High-Power-Yb-doped Amplifiers - 16:15 - 18:15**
**Solid-State Lasers**
***Chaired by: Uwe Morgner**, University of Hannover, Laser Zentrum Hannover, Hannover, Germany*

TuC-T1-I-01 (Invited) 16:15

**Flexible burst-mode ultrafast pump-probe laser for user experiments at the European X-Ray Free-Electron Laser Facility**

*Max Lederer, Mikhail Pergament, Martin Kellert, Kai Kruse, Jinxiong Wang, Guido Palmer, Gerd Priebe, Laurens Wissmann, Ulrike Wegner, Moritz Emons*
*European X-Ray Free-Electron Laser-Facility GmbH, Hamburg, Germany*
We present the concept and development status of our pump-probe laser to be installed at experimental stations of the European XFEL. To date, features such as burst-mode operation with intra-burst frequencies up to 4.5MHz and arbitrary pulse selection are demonstrated at single pulse energies up to 180μJ and 15fs pulsewidth.

TuC-T1-O-02 16:45

**Picosecond, burst-mode fiber laser amplifier with 150 W average power**

*Saniye Sinem Yılmaz[1], Parviz Elahi[1], Hamit Kalaycıoğlu[1], Ihor Pavlov[1], Fatih Ömer İlday[1, 2]*
*[1] Department of Physics, Bilkent University, Ankara, Turkey*
*[2] Department of Electrical and Electronics Engineering, Bilkent University, Ankara, Turkey*
We investigated the burst-mode operation, including ASE generation for a burst-mode fiber laser system which reaches 150 W average power and results indicate that ASE ratio remains in the range of harmless for 200 kHz and higher burst repetition periods and laser system does not require pulsed pumping.

TuC-T1-O-03 17:00

**Burst-mode Yb fiber amplifier system able to produce 40 microjoule individual pulses compressible to 350 femtoseconds**

*Hamit Kalaycıoğlu, Onder Akcaalan, F. Omer Ilday*

MAIN CONFERENCE

*Bilkent University, Physics Department, Ankara, Turkey*

We demonstrate a Yb fiber amplifier system able to produce 10-pulse bursts of 400 µJ total energy with the individual pulses of 40 µJ energy compressible to a width of 350 fs. A chirped fiber brag grating and 1800 l/mm grating compressor is used.

TuC-T1-O-04 17:15

**Generation of sub-100-fs pulses in an Yb: CaGdAlO4 nonlinear regenerative amplifier**

***Julien Pouysegur*[1, 2], *Martin Delaigue*[1], *Yoann Zaouter*[1], *Clemens Hönninger*[1], *Eric Mottay*[1], *Anaël Jaffrès*[3], *Pascal Loiseau*[3], *Bruno Viana*[3], *Patrick Georges*[2], *Frederic Druon*[2]**

*[1] Amplitude Systemes, Pessac, France*

*[2] Laboratoire Charles Fabry, Palaiseau, France*

*[3] Chimie-Paristech, Laboratoire de Chimie de la Matière Condensée de Paris, Paris, France*

Sub-100-fs high-quality pulses have been obtained in an Yb:CALGO regenerative amplifier integrating nonlinear effects. It demonstrates 97fs pulses at 1047nm with 24-µJ energy and 19-nm spectral bandwidth for a gain of 50 dB.

TuC-T1-O-05 17:30

**Energy Scaling of Femtosecond Yb:YAG Single-Crystal Rod Amplifiers using Coherent Beam Combination**

***Marco Kienel*[1, 2], *Michael Müller*[1], *Stefan Demmler*[1], *Jan Rothhardt*[1, 2], *Arno Klenke*[1, 2], *Tino Eidam*[1, 2], *Jens Limpert*[1, 2, 3], *Andreas Tünnermann*[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*

The coherent combination of two Yb:YAG single-crystal rod amplifiers is demonstrated as energy boosters in a fiber chirped-pulse amplification system. In this proof-of-principle experiment, combined and compressed pulses with a duration of 695 fs and an energy of 3 mJ are obtained with a combining efficiency as high as 94%.

TuC-T1-O-06 17:45

**4-fold increase of the mode instability threshold with an Yb-doped multi-core fiber amplifier**

***Hans-Jürgen Otto*[1], *Arno Klenke*[1, 2], *Cesar Jauregui*[1], *Fabian Stutzki*[1], *Jens Limpert*[1, 2], *Anreas Tünnermann*[1, 2, 3]**

*[1] Institute of Applied Physics, Jena, Germany*

*[2] Helmholtz-Institute Jena, Jena, Germany*

*[3] Fraunhofer Institute for Applied Optics and Precision Engineering, Jena, Germany*

A robust and compact setup which employs a multicore fiber with four signal cores is presented. An average output power of 536 W has been extracted, which constitutes a fourfold higher power than possible from a single-core emission of the same fiber due to the onset of mode instabilities.

TuC-T1-O-07 18:00

**Yb-doped rod-type fiber amplifier emitting 2 kW average power**

***Hans-Jürgen Otto*[1], *Cesar Jauregui*[1], *Fabian Stutzki*[1], *Norbert Modsching*[1], *Jens Limpert*[1, 2], *Andreas Tünnermann*[1, 2, 3]**

*[1] Institute for Applied Physics, Jena, Germany*

*[2] Helmholtz-Institute Jena, Jena, Germany*

*[3] Fraunhofer Institute for Applied Optics and Precision Engineering, Jena, Germany*

It is shown that the output average power of rod-type fiber amplifiers can be efficiently increased well beyond the threshold of mode-instabilities. This way a new average output power record of 2 kW, with an M2 of 3, emitted from a 1 meter long rod-type fiber amplifier has been achieved.

**Walk to Harbour - 18:15 - 18:30**

**Boat Trip - 18:30 - 20:15**

## WEDNESDAY SESSIONS

### Aula des Jeunes-Rives

**Lasers for Spectroscopy, Sensing and Imaging - 08:00 - 10:00**
**Special Symposium**
***Chaired by: Ingmar Hartl**, DESY, Hamburg, Germany*

WeA-T3-K-01 (Keynote) 08:00

**Frequency comb measurements outside the laboratory**

***Nathan Newbury***

*NIST, Boulder, United States*

Frequency combs have been exploited in an expanding range of precision measurements, but so far primarily within the metrology laboratory. I will discuss development of a fieldable frequency comb, and experiments that send comb light across outdoor air paths to explore both accurate atmospheric gas measurements and optical time-frequency transfer.

WeA-T3-O-02 08:45

**High-power 5-GHz Yb:CALGO with sub-100 fs pulses**

***Alexander Klenner, Matthias Golling, Ursula Keller***

*Department of Physics, Institute for Quantum Electronics, ETH Zurich, Auguste-Piccard-Hof 1,, Zurich, Switzerland*

A compact 5GHz Yb:CALGO laser delivers 4.12W average output power in sub-100-fs pulses. Stable cw modelocking is achieved using a fast SESAM and a self-stabilizing mechanism against damage from Q-switching. The record-high peak power of 7.5 kW at 5 GHz is expected to be sufficient for stable frequency comb generation.

WeA-T3-I-03 (Invited) 09:00

**Fourier Domain Mode Locking (FDML) for Multi-Megahertz Optical Coherence Tomography (OCT) and Hyperspectral Stimulated Raman Imaging**

***Robert Huber***

*Institut für Biomedizinische Optik, Universität zu Lübeck, Lübeck, Germany*

Fourier Domain Mode Locked lasers use a kilometer long fiber cavity to generate very rapid, narrow linewidth wavelength sweeps over a wide spectral range. These lasers enable optical coherence tomography at Megahertz line rate (MHz-OCT) and time encoded molecular stimulated Raman (Ti-Co-Raman) microscopy.

WeA-T3-O-04 09:30

**Efficient HHG of High Average Power Fiber Lasers Yields More than 100 µW per Harmonic**

***Steffen Hädrich*[1, 2], *Jan Rothhardt*[1, 2], *Arno Klenke*[1, 2], *Manuel Krebs*[1], *Armin Hoffmann*[1], *Oleg Pronin*[3], *Vladimir Pervak*[3], *Jens Limpert*[1, 2], *Andreas Tünnermann*[1, 2, 4]**

*[1] Institute of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller Universität Jena, Albert-Einstein-Straße 15, Jena, Germany*

*[2] Helmholtz-Institute Jena, Fröbelstieg 3, Jena, Germany*

*[3] Ludwig-Maximilian-Universität München, Am*

*Coulombwall 1, München, Germany*
*[4] Fraunhofer Institute of Applied Optics and Precision Engineering, Albert-Einstein-Straße 7, Jena, Germany*
High harmonic generation of a post-compressed high power fiber lasers is achieved with unprecedented efficiency (10-6). A broad plateau (25-40 eV) of strong harmonics (>30 μW) is generated. The strongest harmonic (H25) has an average power of 143 μW (3·1013 photons/s), which constitutes an order of magnitude improvement.

WeA-T3-O-05 09:45

**Mid-IR Waveform Synthesis for HHG Driving**
***Tadas Balciunas*[1], *S. Haessler*[1], *G. Fan*[1], *T. Witting*[2], *A. Zaïr*[2], *G. Andriukaitis*[1], *A. Pugžlys*[1], *J.W.G. Tisch*[2], *J.P. Marangos*[2], *A. Baltuska*[1]**
*[1] Photonics Institute, Vienna University of Technology,, vienna, Austria*
*[2] Blackett Laboratory, Imperial College, London, London, United Kingdom*
*[3] Blackett Laboratory, Imperial College, London, United Kingdom*
We describe the experimental realization of waveform Fourier-synthesis with phase-locked femtosecond color components ranging into the mid-IR spectral region and demonstrate the capability of driving and controlling high-order harmonic generation with these multi-color laser pulses. This, for the first time, extends state-of-the-art strong-field control into the mid-IR spectral region.

## Cafeteria

**Coffee Break - 10:00 - 10:30**

## Aula des Jeunes-Rives

**Brain and Infrared Lasers - 10:30 - 12:15**
**Special Symposium**
***Chaired by: Robert Huber**, University of Luebeck, Luebeck, Germany*

WeB-T3-I-01 (Invited) 10:30

**Fiber-based sources for brain imaging**
***Chris Xu***
*School of Applied and Engineering Physics, Cornell University, Ithaca, NY, United States*
Deep tissue multiphoton microscopy (MPM) using solitons generated from optical fibers are reviewed. The main characteristics of the excitation source for deep tissue MPM, such as wavelength, pulse energy, and repetition rate, are discussed.

WeB-T3-I-02 (Invited) 11:00

**Looking inside the brain: A fiber-optic platform for neurophotonics**
***Aleksei Zheltikov*[1, 2, 4], *L.V. Doronina-Amitonova*[1, 2], *I.V. Fedotov*[1, 2], *O.V. Ivashkina*[2, 3], *M.A. Zots*[2, 3], *A.B. Fedotov*[1, 2], *K.V. Anokhin*[2, 3]**
*[1] Moscow State University, Moscow, Russia*
*[2] Kurchatov Institute National Research Center, Moscow, Russia*
*[3] .K. Anokhin Institute of Normal Physiology, Russi an Academy of Medical Sciences, Moscow, Russia*
*[4] Department of Physics and Astronomy, Texas A&M Uni versity, College Station, Texas, United States*
New fiber-optic neurointerfaces are shown to offer a unique tool for continuous online quantitative monitoring of transcription factor dynamics in the brain of freely behaving mice, suggesting new ways toward understanding neuron plasticity, learning, and memory.

WeB-T3-O-03 11:30

**First Demonstration of a Room-Temperature CW Mid-IR Microcavity Laser**
***Ravi Jain, Mani Hossein-Zadeh***
*University of New Mexico, Albuquerque, United States*
We report the first demonstration of a cw room-temperature mid-IR (2.7-micron) microlaser based on a high-Q 180 μm Er:ZBLAN spherical microresonator pumped by a 980 nm laser diode. Such compact and low threshold power (140 μW) MIR microlasers show strong promise for high-sensitivity ultracompact molecular sensor applications.

WeB-T3-O-04 11:45

**6.5 W $ZnGeP_2$ OPO directly pumped by a Q-switched $Tm^{3+}$-doped single-oscillator fiber laser**
***Christelle Kieleck*[1], *Antoine Berrou*[1], *Brenda Donelan*[1], *Benoît Cadier*[2], *Thierry Robin*[2], *Marc Eichhorn*[1]**
*[1] ISL, French-German Research Institute of Saint-Louis, Saint-Louis, France*
*[2] iXfiber, Lannion, France*
In this paper we report (to the best of our knowledge) the highest ever demonstrated mid-IR output power, 6.5 W, from a directly $Tm^{3+}$:fiber laser pumped $ZnGeP_2$ OPO. The pump laser consists of a polarization maintaining actively Q-switched, $Tm^{3+}$-doped single-oscillator fiber laser.

WeB-T3-O-05 12:00

**High-power linearly-polarized picosecond thulium-doped all-fiber MOPA and mid-IR supercontinuum source**
***Jiang Liu, Pu Wang, Kun Liu, Hongxing Shi, Fangzhou Tan***
*Beijing University of Technology, Beijing, China*
We demonstrated all-polarization-maintaining thulium-doped all-fiber picosecond MOPA system with average output power of 203W and pulse duration of 15ps, the polarization extinction ratio of >15dB. A mid-IR supercontinuum with average output power of 16.2W from 1.9-3.5μm was also demonstrated in a ZBLAN fiber pumped with a short-pulsed thulium-doped fiber amplifier.

## Lunch

**Lunch Break - 12:15 - 13:15**

## Aula des Jeunes-Rives

**Power Scaling of Thin Disk Lasers - 13:15 - 15:30**
**Solid-State Lasers**
***Chair: Christian Kränkel**, University of Hamburg, Hamburg, Germany*

WeC-T1-K-01 (Keynote) 13:15

**Innovative Opportunities for combined High Average and High Peak Power Lasers**
***John Collier***
*Central Laser Facility STFC Rutherford Appleton Laboratory, Oxfordshire, United Kingdom*
In this presentation I will briefly report on the development of a new diode pumped high energy laser concept at the Rutherford Appleton Laboratory (RAL). Known as "DiPOLE", it has been developed to be an intrinsically scalable system, providing a high average power basis for energetic pulse production from Joules to kiloJoules.

WeC-T1-I-02 (Invited) 14:00

**Power-scaling of Kerr-lens mode-locked Yb:YAG thin-disk oscillators**

MAIN CONFERENCE

*Jonathan Brons[1], Vladimir Pervak[2], Elena Fedulova[1], Marcus Seidel[1], Dominik Bauer[3], Dirk Sutter[3], Vladimir Kalashnikov[4], Alexander Apolonskiy[1, 2], Oleg Pronin[2], Ferenc Krausz[1, 2]*
*[1] Max-Planck-Institute of Quantum Optics, Garching, Germany*
*[2] Ludwig-Maximilians-University Munich, Garching, Germany*
*[3] TRUMPF-Laser GmbH + Co. KG, Schramberg, Germany*
*[4] Photonics Institute, TU Wien, Wien, Austria*
A geometrical energy scaling concept for Kerr-lens mode-locked thin-disk oscillators is presented. With an Yb:YAG thin-disk 14.4 µJ, 330 fs pulses at 18.8 MHz repetition-rate are measured. These 270 W average power and 38 MW peak power are the highest of any mode-locked thin-disk oscillator, operated in air.

WeC-T1-O-03 14:30

**100 MHz, MW-level thin-disk oscillator and repetition rate scaling toward 1 GHz**

*Jinwei Zhang[1, 2], Nikolai Lilienfein[1, 3], Jonathan Brons[1], Marcus Seidel[1], Ioachim Pupeza[1, 3], Dominik Bauer[4], Dirk Sutter[4], Vladimir Pervak[3], Zhiyi Wei[2], Alexander Apolonski[1, 3], Oleg Pronin[3], Ferenc Krausz[2, 3]*
*[1] Max-Planck-Institute of Quantum Optics, Hans-Kopfermann-Str. 1, 85748 Garching, Germany, Garching, Germany*
*[2] Beijing National Laboratory for Condensed Matter Physics and Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China, Beijing, China*
*[3] Ludwig-Maximilians-University Munich, Am Coulombwall 1, 85748 Garching, Germany, Garching, Germany*
*[4] TRUMPF-Laser GmbH and Co. KG, Aichhalder Straße 39, 78713 Schramberg, Germany, Schramberg, Germany*
A Kerr-lens mode-locked Yb:YAG thin-disk oscillator delivering 90-W, 250-fs, 0.9-µJ and 50-W, 24-fs, 0.5-µJ (after broadening and compression) pulses at 100 MHz repetition rate is presented. Concepts of scaling the repetition rate up to 1 GHz together with preliminary results are reported.

WeC-T1-O-04 14:45

**SESAM-modelocked dual-gain thin-disk laser based on the sesquioxides Yb:$Lu_2O_3$ and Yb:$Sc_2O_3$**

*Cinia Schriber[1], Florian Emaury[1], Andreas Diebold[1], Matthias Golling[1], Kolja Beil[2], Christian Kränkel[2, 3], Clara Saraceno[1, 4], Thomas Südmeyer[4], Ursula Keller[1]*
*[1] Institute of Quantum Electronics, Physics Departement, ETH Zurich, 8093 Zurich, Switzerland*
*[2] Institut für Laser-Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany*
*[3] The Hamburg Centre for Ultrafast Imaging, Luruper Chaussee 149,, 22761 Hamburg, Germany*
*[4] Laboratoire Temps-Fréquence, Université de Neuchâtel, 2000 Neuchâtel, Switzerland*
We present for the first time a SESAM-modelocked thin-disk laser that incorporates two gain materials with different emission spectra in a single resonator. We demonstrate pulse durations of 103 fs with 1.4 W of average power and 124-fs pulses with 8.6 W at a repetition rate of 41.7 MHz.

WeC-T1-O-05 15:00

**Toward millijoule-level modelocked laser oscillators**

*Clara Saraceno[1, 2], Florian Emaury[1], Cinia Schriber[1], Martin Hoffmann[2], Diebold Andreas[1], Golling Matthias[1], Südmeyer Thomas[2], Ursula Keller[1]*
*[1] ETH Zurich, Zurich, Switzerland*
*[2] University of Neuchatel, Neuchatel, Switzerland*
We investigate energy scaling of SESAM-modelocked thin-disk lasers (TDLs) towards the millijoule level. We used a high-power TDL (9.7MHz, up to 180W) in a pressure-controlled environment and investigated experimentally the influence of different gases at varying pressure levels on the pulse parameters, stability and noise of the oscillator.

WeC-T1-O-06 15:15

**Power Scaling of Solid-State Lasers Using a Rotating Cavity Configuration**

*Matthew Eckold, Callum R Smith, Jacob I Mackenzie, W Andrew Clarkson*
*ORC, University of Southampton, Southampton, United Kingdom*
Using a novel Rotating Cavity Laser architecture we have generated 120W of output at 1.064µm from a single end-pumped ceramic Nd:YAG disk. Evidence confirming the effectiveness of this approach as a technique for mitigating thermally-induced effects as well as preliminary amplifier performance for continuous-wave and Q-switched seed lasers are presented.

## Poster Session 2 - RE 42 / RE 46

**Poster Session 2 with Coffee Break**
**15:30 - 17:00**
Solid-State Lasers / Fibre and Waveguide Devices
A coffee break will take place at the same time (in the cafeteria).

WeP-T2-P-01

**Multiple high-average-power nanosecond laser beams based on rod PCFs for filled-aperture coherent combination.**

*Hidetsugu Yoshida[1], koji Tsubakimoto[1], Hisanori Fujita[1], Noriaki Miyanaga[1], Haik Chosrowjan[2, 3], Masayuki Fujita[2, 3], Yasukazu Izawa[2, 3], Takeshi Yamamura[3, 4], Tomokazu Sakagawa[3, 4]*
*[1] Institute of Laser Engineering, Osaka University, Suita, Osaka, Japan*
*[2] Institute for Laser Technology, Suita, Osaka, Japan*
*[3] Advanced Laser and Process Technology Research Association (ALPROT), Tokyo, Japan*
*[4] Kataoka Corp., Kyoto, Japan*
An average output power of over 180 W (pulse width: 10 ns, energy: 0.6 mJ at 300 kHz) was obtained using an 85 mm-core rod-PCF(DMF) fiber. An excellent beam quality M2 of 1.2 was obtained at 150-180 W levels. Four coherently combined beams with 500 ~ 700 W total power.

WeP-T2-P-02

**Low-energy, all-optical switching of transverse modes in integrated waveguides**

*Tim Hellwig[1], Jörn Epping[2], Martin Schnack[1], Klaus.-J. Boller[2], Carsten Fallnich[1]*
*[1] Institute of Applied Physics, Westfälische Wilhelms-Universität Münster, Münster, Germany*
*[2] Laser Physics & Nonlinear Optics Group, University of Twente, Enschede, Netherlands*
We present a numerical study on all-optical mode-switching in an integrated SiN-waveguide based on transiently induced long-period gratings via the optical Kerr-effect. Phase matching is enabled utilizing material and waveguide birefringence and conversion efficiencies above 90% are observed for write pulse switching energies of approximately 450pJ.

WeP-T2-P-03

**High-power Amplification of Two-tone Laser Pulses in Ytterbium-doped Photonic Crystal Fibers and Their Second-harmonic Generation**

*Yong-Ho Cha, Gwon Lim, Yong-Hee Kim, Hyoun Min Park, Kwang-Hoon Ko, Taek-Soo Kim, Lim Lee, Do-Young Jeong*
*Korea Atomic Energy Research Institute, Daejeon, Korea, Republic of (South)*
A high-power (150 W) two-tone (1056 nm and 1070 nm) narrow-linewidth pulsed laser has been developed based on ytterbium-doped photonic crystal fibers. And, high-power (60 W) two-tone green laser pulses have been generated with second-harmonic generation through two non-critically phase-matched LBO crystals in series.

## WeP-T2-P-04

**$Tm^{3+}$ doped fiber amplifier optimized for picosecond pulse amplification**

*Mateusz Wysmolek[1], Hakan Sayinc[1], Uwe Morgner[1, 2], Jörg Neumann[1], Dietmar Kracht[1]*
*[1] Laser Zentrum Hannover e. V., Hannover, Germany*
*[2] Institut für Quantenoptik Leibniz Universität Hannover, Hannover, Germany*
We present a monolithic fiber-integrated $Tm^{3+}$ doped fiber amplifier pumped at 793 nm optimized for picosecond pulse amplification with an average output power ranging between 0.3 W and approx. 1 W for 2.5 MHz and 40 MHz repetition rates at 1950 nm.

## WeP-T2-P-05

**Pulse compression of a picosecond microchip laser**

*Toshiki Koike[1], Ryutarou Yamashita[1], Kazuyoku Tei[1], Shigeru Yamaguchi[1], Jun Enokidani[2], Shin Sumida[2]*
*[1] Tokai university, Hiratsuka, Japan*
*[2] OPT-i CO., LTD., Kashiwa, Japan*
We demonstrate the direct pulse compression of a pulsed fiber laser which is seeded by a passively Q-switched microchip laser. The output pulse of the fiber laser is chirped and therefore can be compressed by chirped volume Bragg gratings. We achieved the shortest pulse duration of 65 ps.

## WeP-T2-P-06

**Gain isolation by spectral filtering in fiber lasers for material processing**

*Parviz Elahi[1], Fatih Ö Ilday[1, 2]*
*[1] Department of Physics, Bilkent University, TR-06800 Ankara, Turkey, Ankara, Turkey*
*[2] Department of Electrical and Electronics Engineering, Bilkent University, TR-06800 Ankara, Turkey, Ankara, Turkey*
We report on an experimental and theoretical study of a novel technique, which termed gain isolation by spectral filtering. By this method the reflection beam during material processing, which is coupled into the laser, is attenuated and prevents damage of the laser system due to back reflection.

## WeP-T2-P-07

**Imposing Temporal and Frequency Characteristics in a Two-Arm Coherently Combined Q-Switched Photonic Crystal Fiber Laser**

*Boris Rosenstein[1], Avry Shirakov[1, 2], Daniel Belker[1], Amiel Ishaaya[1]*
*[1] Department of Electrical and Computer Engineering, Ben-Gurion University of the Negev, Beer-Sheva, Israel*
*[2] Department of Physics, Ben-Gurion University of the Negev, Beer-Sheva, Israel*
We experimentally investigate passive interferometric coherent combining of two photonic crystal fiber laser channels within a common cavity, wherein only one channel is Q-switched.

## WeP-T2-P-08

**Graphene Oxide paper as a saturable absorber for erbium and thulium doped fiber lasers**

*Jakub Boguslawski[1], Jaroslaw Sotor[1], Grzegorz Sobon[1], Jan Tarka[1], Karol Krzempek[1], Rafal Kozinski[2], Krzysztof Librant[2], Ludwika Lipinska[2], Krzysztof Abramski[1]*
*[1] Laser & Fiber Electronics Group, Wroclaw University of Technology, Wroclaw, Poland*
*[2] Institute of Electronic Materials Technology, Warsaw, Poland*
We report an ultra-short pulse generation in 1.5 and 2 μm spectral ranges using graphene oxide paper based saturable absorbers. Er-doped and Tm-doped fiber lasers produce 515 fs and 1.36 ps soliton pulses, respectively. Simplicity and versatility are major advantages which makes it a promising material for saturable absorber application.

## WeP-T1-P-09

**Optical Fiber Grating Ultrasonic Imaging for Sesimic Physical Modeling Experiments**

*Jingjing Guo[1], Changxi Yang[1], Qun Zhao[2]*
*[1] Tsinghua University, Beijing, China*
*[2] Sinopec Geophysical Research Institute, Nanjing, China*
2D ultrasonic imaging of sesimic physical model is achieved using a phase-shifted fiber grating. Both PZT ultrasonic source , and phase-shifted fiber grating as receiver are mounted on a precise position scanning system. By scanning the phase-shifted grating, 2D image is obtained according to the time-lapse changes in ultrasonic reflection.

## WeP-T1-P-10

**Passively Q-switched, single frequency, 20μm core Yb-doped fiber amplifier**

*Enkeleda Balliu[1], Magnus Engholm[1], Jonas Hellström[2], Gunnar Elgcrona[2], Håkan Karlsson[2]*
*[1] Mid Sweden University, Sundsvall, Sweden*
*[2] Cobolt AB, Solna, Sweden*
We report on a single frequency, nanosecond pulsed, single stage fiber amplifier operating at 1064nm by using an overall fiber core/cladding diameter of 20/125μm. An SBS mitigation technique is applied to the active fiber resulting in average output powers up to 10W and pulse energies up to 337μJ.

## WeP-T1-P-11

**Limits of the ultra-short pulse energy scalability**

*Vladimir Kalashnikov*
*Aston Institute of Photonic Technologies, Aston University, Aston Triangle, Birmingham, United Kingdom*
*Institute for Photonics, TU Wien, Wien, Austria*
The principles of dissipative soliton energy scalability are investigated with taking into account the quantum noises. It is found, that the noises squeeze the energy scalability but the "noise maintaining" would allow enhancing the over-micro-Joule-level pulse generation from a mode-locked laser.

## WeP-T1-P-12

**Ultrafast Soliton Switching in Dual-Core Photonic Crystal Fibre**

*Pavol Stajanca[1], Ignac Bugar[2, 3]*
*[1] Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava, Slovakia*
*[2] International Laser Centre, Bratislava, Slovakia*
*[3] Photonics Institute, Vienna University of Technology, Vienna, Austria*
The optimized dual-core photonic crystal fibre for ultrafast all-optical switching of sub-100 pJ pulses at 1500 nm requiring only sub-centimetre fibre length was designed. Proposed fibre supports nonlinear single-soliton switching with extinction ratio difference in excess of 15 dB at simultaneous pulse compression from 100 fs to 10 fs.

WeP-T1-P-13

**Characterization of Obesity in Murine Skin in vivo by CARS and SHG Microscopy Using a Cost Efficient, Fiber Laser Based Wavelength Extension Unit**

***Dóra Haluszka[1, 2], Robert Szipőcs[1, 3], Norbert Wikonkál[1, 2], Attila Kolonics[1, 3]***

*[1] Institute for Solid State Physics and Optics of Wigner RCP, Budapest, Hungary*

*[2] Department of Dermatology, Venereology and Dermato-oncology, Semmelweis University, Budapest, Hungary*

*[3] R&D Ultrafast Lasers Ltd, Budapest, Hungary*

Inverse correlation was identified between dermal collagen content and the size of the adipocytes in skin of diabetic animal model by a cost efficient, fiber laser based wavelength extension unit for SHG/CARS microscopy.

WeP-T1-P-14

**Coherent Giant Chirp Pulse in Mode-locked Yb-doped Fiber Laser with Excess Dispersion**

***Huihui Li, Jiang Liu, Zhaochen Cheng, Pu Wang***

*National Center of Laser Technology; Institute of Laser Engineering, Beijing University of Technology, Beijing, China*

Coherent giant chirp pulses in Yb-doped fiber laser with excess dispersion were demonstrated. Completely mode-locked operation overcame noise burst with evidences of experimental characteristic cat-ear spectrum and consistent theoretical modeling. Dissipative soliton dynamics were verified as the essence of the coherent mode-locked giant chirp pulse.

WeP-T1-P-15

**Ultrashort-Pulse Nonlinear Fiber CPA System Performance Using Power Amplifiers with Core Diameter from 12.5 to 33 µm**

***Julijanas Želudevičius, Rokas Danilevičius, Karolis Viskontas, Nerijus Rusteika, Kęstutis Regelskis***

*Center for Physical Sciences & Technology, Vilnius, Lithuania*

We investigate experimentally nonlinear fiber CPA system, in which self-phase modulation is utilized both in the fiber stretcher and the power amplifier in order to achieve ultrashort output pulses. System performance in terms of achievable output pulse energy is evaluated using three different Yb-doped fibers for the power amplifier.

WeP-T1-P-16

**60W Nanosecond Pulsed All-Fiber Laser Amplifier**

***Yigit Ozan Aydin, Koray Eken, Sarper Salman***

*FiberLAST Inc., Ankara, Turkey*

In this study, a ytterbium doped all-fiber laser amplifier with 60 W average power and more than 20 kW peak power at 1 µm wavelength was developed. This master-oscillator power-amplifier (MOPA) architectured system is composed of pulses, produced by electronically pumped diode, and amplified by a series of fiber amplifiers.

WeP-T1-P-17

**LED pumped Qcw $Nd^{3+}$:$YVO_4$ laser**

***Adrien Barbet[1], Amandine Paul[2], Jean-Philippe Blanchot[2], Anne-Lise Viotti[2], Frédéric Druon[1], François Balembois[1], Patrick Georges[1]***

*[1] Laboratoire Charles Fabry, UMR 8501, Institut d'Optique, CNRS, Université Paris Sud 11, Palaiseau, France*

*[2] Effilux, Les Ulis, France*

We present the first demonstration of a LED pumped Nd:$YVO_4$ laser at 1064 nm. Transversally pumped by two Qcw LED arrays centered at 850 nm, the laser emits an energy of 40 µJ at 250 Hz for an input pump energy of 7.5 mJ, at room temperature.

WeP-T1-P-18

**Pump threshold optimization of a continuous-wave optical parametric oscillator using a variable-reflectivity volume Bragg grating**

***Peter Zeil, Nicky Thilmann, Valdas Pasiskevicius, Fredrik Laurell***

*Laser physics, KTH Royal Institute of Technology, Stockholm, Sweden*

We present a cw OPO utilizing a 50 mm MgO:PPLN to convert 20 W of pump at 1 µm to 8.2 W of signal power and 5.2 W of idler power at 1.5 µm and 3.4 µm, respectively. A variable-reflectivity volume Bragg grating was employed to optimize the output coupling.

WeP-T1-P-19

**Stable, High-Power, Fiber-Based, Picosecond Ultraviolet Source at 355 nm**

***Chaitanya Kumar Suddapalli[1], Enrique Sanchez Bautista[1], Majid Ebrahim-Zadeh[1, 2]***

*[1] ICFO-Institut de Ciencies Fotoniques, Mediterranean Technology Park, 08860 Castelldefels, Barcelona, Spain*

*[2] Institucio Catalana de Recerca i Estudis Avancats (ICREA), Passeig Lluis Companys 23, Barcelona, Spain*

We report a compact, stable, Yb-fiber-based, all-BIBO, picosecond UV source generating 164 mW of power at 355 nm and 80-MHz repetition-rate with a stability of better than 0.6% rms over 6 hours, in good spatial-beam-quality. The source also provides 4.9 W of green power with 0.4% rms stability in high-beam-quality.

WeP-T1-P-20

**Tm,Ho:KLu($WO_4$)$_2$ laser mode-locked around 2 µm by single-walled carbon nanotubes**

***Veselin Aleksandrov[1, 2], Alexander Gluth[2], Valentin Petrov[2], Ivan Buchvarov[1], Sun Young Choi[3], Mi Hye Kim[3], Fabian Rotermund[3], Xavier Mateos[4], Francesc Diaz[4], Uwe Griebner[2]***

*[1] Physics Department, Sofia University, Sofia, Bulgaria*

*[2] Max Born Institute for Nonlinear Optics and Short Pulse Spectroscopy, Berlin, Germany*

*[3] Division of Energy Systems Research, Ajou University, Suwon, Korea, Republic of (South)*

*[4] Fisica i Cristal.lografia de Materials i Nanomaterials, Universitat Rovira i Virgili, Tarragona, Spain*

Tm,Ho-codoped laser mode-locking based on a single-walled carbon nanotube saturable absorber which is applied to the Ho-ion transition at 2 µm is reported. The Tm,Ho:KLu($WO_4$)$_2$ laser emits nearly time-bandwidth limited pulses with a duration of 2.8 ps at a repetition rate of 91 MHz and 97 mW output power.

WeP-T1-P-21

**Solitary Pulse-on-Demand Production by Optical Injection Locking of Passively Q-Switched InGaN Diode Lasers Near Lasing Threshold**

***Xi Zeng[1], Luca Sulmoni[2], Jean-Michel Lamy[2], Thomas Stadelmann[1], Sylvain Grossmann[1], Arno Hoogerwerf[1], Nicolas Grandjean[2], Dmitri Boïko[1]***

*[1] Centre Suisse d'Electronique et de Microtechnique SA (CSEM), Neuchâtel, Switzerland*

*[2] Institute of Condensed Matter Physics (ICMP), École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland*

We report on optical injection locking of Q-switched InGaN multi-section diode laser from CW tunable laser to produce solitary pulses at precise wavelength. To the best of our knowledge, this has never been done before.

MAIN CONFERENCE

WeP-T1-P-22

**Laser-induced damage of $CdSiP_2$ and comparison with $ZnGeP_2$ at two OPO pump wavelengths: 1.064 µm and 2.09 µm**

*Anne Hildenbrand[1], Christelle Kieleck[1], Aleksey Tyazhev[2], Georgi Marchev[2], Peter G. Schunemann[3], Valentin Petrov[2], Marc Eichhorn[1]*

*[1] French-German Research Institute of Saint-Louis (ISL), Saint-Louis, France*

*[2] Max-Born-Institute for Nonlinear Optics and Ultrafast Spectroscopy, Berlin, Germany*

*[3] BAE Systems, Nashua, United States*

$CdSiP_2$ (CSP) is a very promising nonlinear crystal for mid-infrared optical parametric oscillators (OPOs). In this work, the damage resistivity of uncoated CSP is compared to $ZnGeP_2$ (ZGP) at two wavelengths, 1.064 µm and 2.09 µm, to investigate current limitations and future routes of optimization.

WeP-T1-P-23

**Carrier-envelope Phase Changes of Few-cycle Pulses Focused by Lenses: Simulations and Measurements**

*Balazs Major[1], Miguel A. Porras[2], Daniel Nemes[1], Attila P. Kovacs[1], Zoltan L. Horvath[1]*

*[1] Department of Optics and Quantum Electronics, University of Szeged, Szeged, Hungary*

*[2] Departamento de Fisica Aplicada a los Recursos Naturales and Grupo de Sistemas Complejos, Universidad Politecnica de Madrid, Madrid, Spain*

We present simulations and measurements on the carrier-envelope phase (CEP) changes of few-cycle optical pulses focused by lenses or lens systems. We show how undistorted focusing is possible with lenses and how the focal CEP shift can be tailored by special separable achromatic doublets.

WeP-T1-P-24

**A high power Ti:sapphire laser with synchronized Yb-fiber amplifier for nonlinear optical microscopy and optical coherence tomography**

*A Fernandez[1], A Verhoef[1], T Kamali[2], A Hansen[3], O Jensen[3], P Andersen[3], B Sumpf[4], G Erbert[4], P Petersen[3], A Baltuska[1]*

*[1] Photonics Institute, TU Wien, Wien, Austria*

*[2] Medical University Vienna, Wien, Austria*

*[3] Department of Photonics Engineering, Technical University of Denmark, Roskilde, Denmark*

*[4] Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik, Berlin, Germany*

A simple scheme of a compact femtosecond Ti:sapphire laser with synchronized Yb-fiber amplifier implemented in a combined coherent Anti-Stokes Raman and optical coherence tomography platform is presented. Through spectral shifting part of the Ti:sapphire output and amplification in the Yb-fiber amplifier CARS signals in the lipid region can be addressed.

WeP-T1-P-25

**Single-longitude-mode emission of multi-mode-interferometer-Fabry-Perot laser diode**

*Hua Yang[1], Padraic Morrissey[1], Brian Corbett[1], Frank Peters[1, 2]*

*[1] Tyndall National Institute, UCC, Cork, Ireland*

*[2] Department of Physics, University College Cork, Cork, Ireland*

We demonstrate a novel multimode-interferometer-Fabry-Perrot laser diode generating single wavelength emission. The designed and fabricated laser shows a SMSR 25dBm and can be tuned over a certain range using injection current. The simple structure significantly eases the processing enabling an increase in the yield and a reduction in the cost.

WeP-T1-P-26

**A Frequency-locked and Frequency Doubled Q-switched Yb:KYW Laser at 515 nm**

*Staffan Tjörnhammar, Andrius Zukauskas, Carlota Canalias, Valdas Pasiskevicius, Fredrik Laurell*

*Department of Applied Physics, KTH, Stockholm, Sweden*

A compact, hybrid Q-switched Yb:KYW laser was frequency doubled in PPKTP with a conversion efficiency of 66%. The laser was frequency locked and stabilized with a volume Bragg grating and the repetition frequency could be varied between 30 Hz and 3 kHz giving pulse energies between 200 and 250 µJ.

WeP-T1-P-27

**Diode-Pumped Actively Mode-Locked Tm:YLF Laser**

*Jiří Mužík, Michal Jelínek, David Vyhlídal, Václav Kubeček*

*Czech Technical University, Faculty of Nuclear Sciences and Physical Engineering, Praha, Czech Republic*

To our knowledge, this is the first report of realization of an actively mode-locked, continuously pumped Tm:YLF laser. Stable train of pulses with repetition rate of 150 MHz, width of 220 ps and maximum optical output power of 2.6 W at 1910 nm was achieved.

WeP-T1-P-28

**Effects of Chemical Mechanical Polishing on the Laser Induced Damage Threshold of $ZnGeP_2$**

*Olivier Muller[1], Anne Hildenbrand[1], Christelle Kieleck[1], Antoine Berrou[1], Florence Moitrier[1], Marc Eichhorn[1], Lothar Ackermann[2], Klaus Dupré[2], Johan Petit[3], Antoine Godard[4]*

*[1] ISL French-German Research Institute of Saint-Louis, Saint-Louis, France*

*[2] FEE Forschungsinstitut für mineralische und metallische Werkstoffe-Edelsteine/Edelmetalle, Idar-Oberstein, Germany*

*[3] ONERA - The French Aerospace Lab, Châtillon, France*

*[4] ONERA - The French Aerospace Lab, Palaiseau, France*

It is known that laser-induced damage in $ZnGeP_2$ single crystals always initiates at the surfaces rather than in the bulk, making the surface preparation of major importance. We studied two chemical mechanical polishing processes. Peak to valley flatness and laser-induced damage threshold were analyzed and compared to commercial polish results.

WeP-T1-P-29

**Spatial Hole Burning in Yb:YAG Thin-Disk Lasers: effects of polarization and spectral gain**

*Christian Vorholt, Ulrich Wittrock*

*Photonics Laboratory, University of Applied Sciences, Steinfurt, Germany*

We have investigated the influence of spatial hole burning on the optical spectrum and output power in Yb:YAG thin-disk lasers in cw-operation. Simulation results of I-shaped and V-shaped resonators are in very good agreement with our measurements. It is shown that many subtle effects are directly related to spatial hole burning.

WeP-T1-P-30

**Peculiarities of second harmonics generation with a constant wave-number mismatch gradient along a nonlinear crystal**

*Kęstutis Regelskis, Julijanas Želudevičius, Viktorija Žvirblytė, Gediminas Račiukaitis*

*Department of Laser Technology, Center for*

*Physical Sciences & Technology, Vilnius, Lithuania*
We investigated peculiarities of the second harmonics generation with constant wave-number mismatch gradient along a nonlinear crystal. Behaviour of the second harmonic complex amplitude was geometrically visualized by means of the Cornu spiral. Phase-matching bandwidths of the second harmonics generation with and without wave-number mismatch gradient are compared.

WeP-T1-P-31

**Pumping wavelength influence on Tm:Ho:$CaF_2$ ceramics laser**

***Jan Sulc[1], Michal Nemec[1], Maxim Doroshenko[2], Helena Jelinkova[1], Martin Fibrich[1], Pavel Fedorov[2], Vjatcheslav Osiko[2]***

*[1] Czech Technical University in Prague Faculty of Nuclear Sciences and Physical Engineering, Prague, Czech Republic*

*[2] Russian Academy of Sciences A. M. Prokhorov General Physics Institute, Moscow, Russia*

Performance of Tm:Ho:$CaF_2$ (2%Tm, 0.3%Ho) ceramics laser, operating at wavelength 2.1 μm, pumped successively at wavelengths 782 nm, 1700 nm, and 1945 nm, is presented. It was found, that the laser slope efficiency (better than 10%) in respect to absorbed pumping power is not significantly dependent on pumping channel.

WeP-T1-P-32

**Active image wavelength up-conversion from the 1550 nm spectral region to 631 nm in an $Nd^{3+}$:$YVO_4$ laser with an intra-cavity PPLN crystal using ASE illumination**

***Adrian J. Torregrosa[1], Haroldo Maestre[1], Maria Luisa Rico[2], Juan Capmany[1]***

*[1] Department of Communications Engineering. Miguel Hernandez University., Elche, Spain*

*[2] Department of Computer Technology. University of Alicante,, Alicante, Spain*

We present an active image wavelength conversion system based on sum-frequency mixing of a 1550 nm ASE illuminated target and a 1064 nm $Nd^{3+}$:$YVO_4$ continuous-wave laser with an intra-cavity periodically poled lithium niobate crystal.

WeP-T1-P-33

**Joint Influence of Cubic Nonlinearity and Thermally Induced Birefringence on the Radiation Polarization in High Peak Power Lasers**

***Maryana Kuzmina, Efim Khazanov, Andrey Stepanov***

*Nonlinear Dynamics and Optics Division, Institute of Applied Physics of the Russian Academy of Sciences, Nizhny Novgorod, Russia*

Co-influence of the cubic nonlinearity and the thermally induced birefringence on the radiation polarization in high peak and average power lasers was investigated. Both effects introduce polarization distortions in the laser beam, giving rise to power losses. Methods that significantly reduce the revealed negative impact were developed for key optical laser elements.

WeP-T1-P-34

**Theoretical analysis for ultrashort pulse mode-locked Yb:YAG lasers with an intra-cavity highly nonlinear medium**

***Akiyuki Maruko, Takeshi Yoshida, Masatoshi Nishio, Keisuke Kyomoto, Kento Kato, Hiroaki Okunishi, Sakae Kawato***

*University of Fukui, Fukui, Japan*

From the theoretical analysis on a mode-locked Yb:YAG laser with an intra-cavity highly-nonlinear medium, the output bandwidth was stretched to approximately 5 times broader than the gain bandwidth. The results agree with the experiments qualitatively.

WeP-T1-P-35

**Investigation of Resonator Mirrors GDD Influence on Synchronously Pumped Femtosecond OPO Tuning Properties**

***Karolina Stankevičiūtė[1], Simonas Kičas[2], Ieva Pipinytė[1], Mikas Vengris[1], Rimantas Grigonis[1], Ramutis Drazdys[2], Valdas Sirutkaitis[1]***

*[1] Laser Research Center, Vilnius University, Vilnius, Lithuania*

*[2] Center for Physical Sciences and Technology, Vilnius, Lithuania*

Influence of the cavity dispersion on synchronously pumped femtosecond BBO OPO tuning properties was investigated. Cavity dispersion was estimated from GDD measurements of all resonator mirrors performed by white light interferometry. Experimentally observed jumps from one wavelength to another in the vicinity of GDD oscillations.

WeP-T1-P-36

**A high repetition rate, diode pumped, mechanically Q-switched Er:YSGG laser at 3μm**

***Emma Arbabzadah, Francis Murphy, Chris Phillips, Michael Damzen***

*Imperial College London, London, United Kingdom*

High repetition rate, mechanical Q-switching of a diode-pumped Er:YSGG laser at ~3μm is presented. Two configurations are investigated, with a rotating polygon acting as a rotating back mirror or intracavity chopper to induce Q-switching. Pulse energies >0.5mJ, repetitions rates of 200Hz and pulse durations as short as 83ns are achieved.

WeP-T1-P-37

**Broadband near-infrared luminescence from bismuth-doped leucite and pollucite aluminosilicate crystals. Evidence for the univalent bismuth $Bi^+$ monocation as the new luminescent center.**

***Alexey Romanov[1], Alexander Veber[2], Zukhra Fattakhova[3], Elena Haula[3], Daria Vtyurina[3], Dmitry Shashkin[3], Vladimir Korchak[3], Vladimir Tsvetkov[2], Vladimir Sulimov[1]***

*[1] Research Computer Center of M.V. Lomonosov Moscow State University, Moscow, Russia*

*[2] A.M. Prokhorov General Physics Institute, Russian Academy of Sciences, Moscow, Russia*

*[3] N.N. Semenov Institute of Chemical Physics, Russian Academy of Sciences, Moscow, Russia*

Near-IR photoluminescence from monocations $Bi^+$ was demonstrated for the first time from bismuth-doped aluminosilicates leucites and pollucite. $Bi^+$ can substitute isomorphically for $K^+$ and $Cs^+$ in these crystals. The photoluminescence spectra of bismuth-doped leucites are sufficiently sharper, then the spectra of glasses with the same composition.

WeP-T1-P-38

**Improved power-scaling performance of semiconductor disk lasers with non-circular pump spots**

***Loyd McKnight, John-Mark Hopkins***

*Fraunhofer Centre for Applied Photonics, Glasgow, United Kingdom*

Power scaling in semiconductor disk lasers is limited by the thermal impedance of the DBR and the substrate for an unthined device. In this work we show with finite element thermal modelling that improved power-scaling performance can be achieved with elliptical pump geometries for non-ideal thin disk lasers.

## Aula des Jeunes-Rives

**Waveguide- and Microresonator-based Sources - 17:00 - 18:45**
**Fibre and Waveguide Devices**
***Chaired by: Johan Nilsson**, University of Southampton, ORC, Southampton, United Kingdom*

WeD-T2-O-01 17:00

**Temporal Soliton Generation in Chip-based Silicion Nitride Microresonators**
***Victor Brasch, Tobias Herr, Martin Huber Peter Pfeiffer, John David Jost***
*LPQM - ICMP - SB - EPFL, Lausanne, Switzerland*
We demonstrate temporal dissipative soliton generation in silicion nitride microresonators for the first time. It is shown that this state generates a low noise RF beatnote. Temporal soliton states allow for low-noise RF-generation, smooth frequency comb spectra and produce ultra-short optical pulses on a chip.

WeD-T2-O-02 17:15

**Temporal Solitons in Optical Microresonators: Design Criteria and Spectral Broadening**
***Tobias Herr[1], John Jost[1], Victor Brasch[1], Ivan Mirgorodski[1], Grigoriy Lihachev[2], Michael Gorodetsky[2, 3], Tobias Kippenberg[1]***
*[1] Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland*
*[2] Faculty of Physics, M.V.Lomonosov Moscow State University, Moscow, Russia*
*[3] Russian Quantum Center, Skolkovo, Russia*
Temporal dissipative cavity solitons enable ultra-short high repetition rate optical pulse and frequency comb generation in microresonators. We investigate soliton formation in multi-mode microresonators and derive resonator design criteria. Moreover, we demonstrate nonlinear spectral broadening of the soliton pulses to more than two-thirds of an octave as required for self-referencing.

WeD-T2-O-03 17:30

**Efficient red and orange laser action and first green laser operation with a Pr-doped $YLiF_4$ epitaxial waveguide**
***Western Bolaños, Alain Braud, Jean Louis Doualan, Gurvan Brasse, Richard Moncorgé, Patrice Camy***
*Centre de Recherche sur les Ions, les Matériaux et la Photonique (CIMAP), UMR 6252 CEA-CNRS-Ensicaen, Caen, France*
Green laser emission at 522.5 nm with an average output power of 66 mW and a slope efficiency of 11% is demonstrated for the first time with a crystalline fluoride waveguide. Improved laser efficiencies of 32% and 40% are also obtained at 604 and 639 nm in the cw regime

WeD-T2-O-04 17:45

**Supercontinuum generation in thick silicon nitride waveguides**
***Jörn Epping[1], Tim Hellwig[2], Marcel Hoekman[3], Arne Leinse[3], Rene Heideman[3], Peter van der Slot[1], Chris Lee[1], Carsten Fallnich[2], Klaus Boller[1], Richard Mateman[3], Albert van Rees[5]***
*[1] Univerversity of Twente, Enschede, Netherlands*
*[2] University of Münster, Münster, Germany*
*[3] LioniX BV, Enschede, Netherlands*
*[4] University of Twente, Enschede, Netherlands*
*[5] XiO Photonics BV, Enschede, Netherlands*
Based on a novel method for fabricating crack-free and thick silicon nitride waveguides with a thickness of up to 800 nm, phase-matching for nonlinear optics is achieved. We demonstrate the high suitability of these waveguides for nonlinear optics through supercontinuum generation across more than 460 nm spectral bandwidth.

WeD-T2-O-05 18:00

**Multi-Watt Continuous Wave Output Power and Q-switched Laser Operation of Femtosecond-Laser Inscribed Yb:YAG Based Waveguides**
***Thomas Calmano[1], Sebastian Müller[1], Christian Kränkel[1, 2], Günter Huber[1, 2]***
*[1] Institut für Laser-Physik, Universität Hamburg, Hamburg, Germany*
*[2] The Hamburg Centre for Ultrafast Imaging, Hamburg, Germany*
Channel waveguides were fabricated in Yb:YAG and composite Yb:YAG/$Cr^{4+}$:YAG by femtosecond-laser writing. OPS-pumped continuous wave Yb:YAG waveguide-lasers exhibited output powers of 5.2W and optical-to-optical efficiencies of 68%. Q-switched laser operation with ns pulse duration at 600kHz repetition rate and µJ pulse energy was demonstrated with Ti:sapphire-laser-pumped Yb:YAG/$Cr^{4+}$:YAG waveguides.

WeD-T2-O-06 18:15

**Efficient conversion to radial polarisation in the two-micron band using a continuously space-variant half-wave plate**
***DI LIN, Peter Shardlow, Martynas Beresna, Peter Kazansky, Andrew Clarkson***
*Optoelectronics Research Centre, University of Southampton, SOUTHAMPTON, United Kingdom*
We demonstrate efficient conversion of a linearly-polarized Gaussian beam to a radially-polarised doughnut beam in the two-micron band using a continuously space-variant half-waveplate created by femtosecond writing of subwavelength gratings. The low scattering loss (<0.07) of this device indicates that it would be suitable for use with high power lasers.

WeD-T2-O-07 18:30

**Diamond diced $Yb^{3+}$ doped $In_2O_3$ ridge waveguides**
***Sven H. Waeselmann[1], Sebastian Heinrich[1], Christian E. Rüter[2], Detlef Kip[2], Christian Kränkel[1, 3], Günter Huber[1, 3]***
*[1] Institut für Laser-Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Hamburg, Germany*
*[2] Faculty of Electrical Engeneering, Helmut Schmidt Universität, 22043 Hamburg, Hamburg, Germany*
*[3] The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Hamburg, Germany*
Thin $Yb^{3+}$ doped Indium-Oxide films were grown epitaxially on Lutetium-Oxide substrates via pulsed laser deposition. In order to prepare ridge waveguides, precise diamond blade dicing was applied. Due to the high refractive index difference compared to Lutetium-Oxide, the $In_2O_3$ ridges are interesting for small optically active waveguides.

## Break and Walk to Dinner

**18:45 – 19:15**

## Conference Dinner

**19 :15 – 21 :30**

# THURSDAY SESSIONS

## Aula des Jeunes-Rives

**Novel Fiber Amplifiers - 08:00 - 10:00**
**Fibre and Waveguide Devices**
***Chaired by: Yoann Zaouter**, Amplitude Systèmes, Evry, France*

MAIN CONFERENCE

A-T2-K-01 (Keynote) 08:00

**Performance Scaling of Ultrafast Fiber Laser Systems**

***Jens Limpert***
*Friedrich-Schiller-Universität Jena, Jena, Germany*

The presentation will review challenges and achievements of ultrashort pulse amplification in rare-earth-doped fibers as well as the basics of the concept "coherent addition of pulsed laser radiation" and its use for performance scaling. Finally, a design is presented which targets Joule-class femtosecond pulses at repetition rates beyond 10kHz.

ThA-T2-I-02 (Invited) 08:45

**Ultrashort-pulse Enhancement Cavities and Applications**

***Ioachim Pupeza[1, 2], Simon Holzberger[1, 2], Henning Carstens[1, 2], Nikolai Lilienfein[1, 2], Tino Eidam[3], Christoph Jocher[3], Vladimir Pervak[2], Alexander Apolonski[1, 2], Jens Limpert[3], Andreas Tünnermann[3], Ernst Fill[1, 2], Ferenc Krausz[1, 2]***
*[1] Max-Planck-Institut für Quantenoptik, Garching, Germany*
*[2] Ludwig-Maximilians-Universität München, München, Germany*
*[3] Friedrich-Schiller-Universität Jena, Institut für Angewandte Physik, Jena, Germany*

We review the challenges and the newest developments in scaling the performance of ultrashort-pulse enhancement cavities. Using state-of-the-art Yb:fiber lasers, custom mirrors and cavity designs, we demonstrate at 78-MHz repetition rate 1.9-kW average-power 40-fs pulses and, at 250 MHz, 400 kW with 250-fs pulses and 670 kW with 10-ps pulses.

ThA-T2-O-03 09:15

**88 W sub-ps thulium-doped fiber CPA system**

***Fabian Stutzki[1], Christian Gaida[1], Martin Gebhardt[1], Florian Jansen[1], Andreas Wienke[2], Cesar Jauregui[1], Jens Limpert[1, 3, 4], Andreas Tünnermann[1, 3, 4], Frank Fuchs[3], Dieter Wandt[2], Dietmar Kracht[2]***
*[1] Institute of Applied Physics, Jena, Germany*
*[2] Laser Zentrum Hannover e.V., Hannover, Germany*
*[3] Fraunhofer Institute for Applied Optics and Precision Engineering, Jena, Germany*
*[4] Helmholtz-Institute Jena, Germany, Jena, Germany*

We demonstrate a Tm-doped fiber CPA system with a new record compressed average output power of 88W and a peak power of 2MW. This record is enabled by the use of Tm-doped photonic crystal fibers with 36µm mode field diameter and more than 50% slope efficiency.

ThA-T2-O-04 09:30

**Overcoming gain-narrowing in femtosecond fiber amplifiers using coherent combining of separately amplified spectra**

***Florent Guichard[1, 2], Marc Hanna[1], Laurent Lombard[3], Yoann Zaouter[2], Clemens Hönninger[2], Franck Morin[2], frederic Druon[1], Eric Mottay[2], Patrick Georges[1]***
*[1] Laboratoire Charles Fabry, Palaiseau, France*
*[2] Amplitude Systèmes, Pessac, France*
*[3] Office National d'Etudes et de Recherches Aérospatiales, Palaiseau, France*

We demonstrate spectral coherent combining of two FCPA seeded by a common oscillator.130 fs pulses with a spectral width of 19 nm at high gain value of 30 dB are thus generated, highlighting the strong potential of pulse synthesis for the reduction of the minimum pulse duration in FCPA.

ThA-T2-O-05 09:45

**High power radially-polarized Yb-doped fiber laser**

***DI LIN, Jae Daniel, Mindaugas Gecevičius, Martynas Beresna, Peter Kazansky, Andrew Clarkson***
*Optoelectronics Research Centre, University of Southampton, SOUTHAMPTON, United Kingdom*

A simple technique for directly generating a radially-polarized output beam from an ytterbium-doped fiber laser using an intracavity spatially-variant waveplate is reported. The laser yielded 32W of output with a corresponding slope efficiency of 65.8% in a radially-polarized beam with beam propagation factor ~2.1 and polarization purity >95%.

## Cafeteria

**Coffee Break - 10:00 - 10:30**

## Aula des Jeunes-Rives

**Frequency Combs and Supercontinua - 10:30 - 12:15**
**Solid-State Lasers**

***Chaired by: Andrius Baltuska**, Vienna University of Technology, Vienna, Austria*

ThB-T1-O-01 10:30

**SESAM-based fast Actuator for DPSSL Comb Frequency Stabilization**

***Stéphane Schilt, Hoffmann Martin, Thomas Südmeyer***
*Laboratoire Temps-Fréquence, Université de Neuchâtel, Neuchâtel, Switzerland*

We evaluate the performance of a SESAM as fast opto-optical modulator for stabilization of a DPSSL frequency comb. 10-time higher modulation bandwidth of $f_{CEO}$ and frep is shown compared to gain-modulation, leading to comb self-referencing with significantly improved noise performance and high potential for phase-locking to an optical reference.

ThB-T1-O-02 10:45

**Wavelength Conversion by Injection Locking to an Optical Comb for Optical Frequency Transfer Applications**

***Joonyoung Kim[1], David Wu[1], Guiseppe Marra[2], David Richardson[1], Radan Slavík[1]***
*[1] Optoelectronics Research Centre, University of Southampton, Southampton, United Kingdom*
*[2] National Physics Laboratory, Teddington, United Kingdom*

We propose use of optical injection locking of a semiconductor laser to an optical comb to enable wavelength conversion in precision optical frequency transfer applications. We were able to perform wavelength conversion up to 500 GHz (4 nm) which was limited due to the tuning range of the slave laser.

ThB-T1-O-03 11:00

**Self-referenceable frequency comb with 140 W of average power**

***Andreas Diebold[1], Florian Emaury[1], Cinia Schriber[1], Clara Saraceno[1, 2], Thomas Südmeyer[2], Ursula Keller[1]***
*[1] Institute of Quantum Electronics, ETH Zurich, Zurich, Switzerland*
*[2] Laboratoire Temps-Fréquence, Université de Neuchâtel, Neuchâtel, Switzerland*

We detected the carrier-envelope-offset (CEO) frequency of a 9MHz, 760fs SESAM-modelocked Yb:YAG thin-disk laser delivering 140W of average power. We compressed a small fraction of the power (1.5W) to 63fs in a standard photonic-crystal-fibre and detected strong CEO beats (signal-to-noise ratio >33 dB, resolution-bandwidth 100kHz) using an f-to-2f interferometer.

ThB-T1-O-04 11:15

**Supercontinuum Generation from a 1.75-GHz SESAM Modelocked VECSEL and Carrier Envelope Offset Frequency Detection**

*Christian A. Zaugg[1], Alexander Klenner[1], Mario Mangold[1], Aline S. Mayer[1], Sandro M. Link[1], Matthias Golling[1], Emilio Gini[2], Clara J. Saraceno[1, 3], Bauke W. Tilma[1], Ursula Keller[1], Florian Emaury[1]*

*[1] ETH Zürich, Department of Physics, Institute for Quantum Electronics, Zürich, Switzerland*

*[2] ETH Zürich, FIRST Center for Micro- and Nanoscience, Zürich, Switzerland*

*[3] Université de Neuchâtel, Laboratoire Temps-Fréquence, Neuchâtel, Switzerland*

We detect the carrier envelope offset frequency of a modelocked vertical-external-cavity surface-emitting laser (VECSEL). The octave-spanning super-continuum, required for the f-to-2f-interferometer, was generated with a highly nonlinear photonic-crystal-fiber. Prior to that, 1.75-GHz, 240-fs pulses (100 mW) from the VECSEL were amplified and compressed to 105 fs (1.4 W).

ThB-T1-O-05 11:30

**Tunable quasi-phase-matched high-order harmonic generation**

*Kevin O'Keeffe, David Lloyd, Simon Hooker*

*Department of Physics, University of Oxford, Oxford, United Kingdom*

Tunable quasi-phase-matched high harmonic generation is demonstrated using trains of counter-propagating ultrafast pulses, in which the linear separation between pulses can be varied continuously over a large range.

ThB-T1-O-06 11:45

**High-Power Few-Cycle Pulse Generation by Spectral Broadening in Bulk Material**

*Marcus Seidel[1], Jonathan Brons[1], Elena Fedulova[1], Vladimir Pervak[2], Alexander Apolonski[1, 2], Oleg Pronin[2], Ferenc Krausz[1, 2]*

*[1] Max-Planck-Institute of Quantum Optics, Munich, Germany*

*[2] Ludwig-Maximilians-University, Munich, Germany*

The first 10-W, 10-fs amplification-free laser is presented. Bulk spectral broadening is utilized to reach the pulse duration of less than three optical cycles. By stronger focusing, spectral broadening down to a sub-two-cycle pulse Fourier transform limit is shown. Spectral homogeneity and good quality of the laser beam are demonstrated.

ThB-T1-O-07 12:00

**Full 3D Simulation of White-Light Generation in Bulk Materials**

*Aradhana Choudhuri[1], Haider Zia[1], Ann-Laure Calendron[2], Huseyin Cankaya[2], Franz X. Kärtner[2, 3], Ingmar Hartl[2], R.J. Dwayne Miller[1, 3], Axel Ruehl[2]*

*[1] Max-Planck Institute for the Structure and Dynamics of Matter, HamBurg, Germany*

*[2] Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany*

*[3] Department of Physics and The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Hamburg, Germany*

We present the first full-3D approach to simulating white-light generation in bulk materials. Our approach extends the split-step method by operating in the momentum-frequency/spatio-temporal domains, and uses a derived summation identity to model all higher-order dispersion without Taylor expansion. Simulation results are in good agreement with experimental data.

## Lunch

**Lunch Break - 12:15 - 13:15**

## Aula des Jeunes-Rives

**Low-noise Fiber Lasers and Spectroscopy - 13:15 - 15:15**
**Fibre and Waveguide Devices**

***Chaired by: Ingmar Hartl**, DESY, Hamburg, Germany*

ThC-T2-O-01 13:15

**Generation of Tunable Few-Cycle mid-IR Pulses by Guided-Wave Optical Parametric Amplification**

*Tobias Flöry[1], Pavel Malevich[1], Audrius Pugžlys[1], Alexander Voronin[2], Aleksei Zheltikov[2, 3], Andrius Baltuška[1]*

*[1] Photonics Institute, Vienna University of Technology, Vienna, Austria*

*[2] Physics Department, International Laser Center, M.V. Lomonosov Moscow State University, Moscow, Russia*

*[3] Department of Physics and Astronomy, Texas A&M University, College Station, TX, United States*

Optical parametric amplification of seed in the visible by near-infrared pump in a gas-filled hollow waveguide enables the generation of tunable ultrashort pulses in the mid-infrared, delivered in a robust, well-controlled spatial mode. As predicted by numerical simulations, complicated amplification dynamic leads to nonlinear compression of the amplified pulses.

ThC-T2-O-02 13:30

**Precision Limitation in Coherent Laser Ranging due to Speckle phase-noise**

*Esther Baumann, Jean-Daniel Deschênes, Fabrizio R. Giorgetta, William C. Swann, Ian Coddington, Nathan R. Newbury*

*NIST, Boulder, United States*

The ultimate precision of coherent laser three-dimensional mapping of a diffusely scattering surface will be determined by speckle noise. Speckle phase noise gives rise both to apparent range outliers and to excess range noise during lateral scans. Nevertheless at 1 THz optical bandwidth, range precisions below 10 µm are achievable.

ThC-T2-O-03 13:45

**Relative intensity noise of Raman solitons**

*Gengji Zhou[1], Wei Liu[1], Jinkang Lim[2], Hung-Wen Chen[2], Franz Kärtner[1, 2, 3], Guoqing Chang[1, 2]*

*[1] Center for Free-Electron Laser Science, DESY, Hamburg, Germany*

*[2] Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, United States*

*[3] Physics Department, University of Hamburg, Hamburg, Germany*

By experimentally and numerically study the relative intensity noise (RIN) of Raman solitons, we show that, depending on the fiber's dispersion, earlier ejected Raman soliton exhibits lower or higher RIN than the later one. Using fiber with right dispersion, we demonstrate low-noise watt-level, 3-GHz Raman soliton source at 1350 nm.

ThC-T2-O-04 14:00

**Tunable diode laser absorption spectroscopy of $CO_2$ at 2051 nm using sealed hollow core fibre cells**

*Christopher Edwards[1], Geoffrey Barwood[1], Patrick Gill[1], Natalie Wheeler[2], John Wooler[2], Yong Chen[2], Francesco Poletti[2], Marco Petrovich[2], David Richardson[2], Richard Phelan[3]*

*[1] National Physical Laboratory, Teddington, United Kingdom*

*[2] Optoelectronics Research Centre, University of Southampton, Southampton, United Kingdom*

*[3] Eblana Photonics, Dublin, Ireland*

MAIN CONFERENCE

Diode laser spectroscopy with sealed $CO_2$-filled photonic crystal microcells is under development for atmospheric green house gas monitoring at 2051 nm. This paper presents the fabrication and spectroscopic evaluation of low and high pressure fibre cells.

ThC-T2-O-05 14:15

**High-Resolution $CO_2$ Phase Spectra Measured over an Open Air Path with a Dual-Comb Spectrometer**

*Fabrizio Giorgetta[1], Greg Rieker[3], Ian Coddington[1], William Swann[1], Alex Zolot[2], Laura Sinclair[1], Esther Baumann[1], Christopher Cromer[1], Nathan Newbury[1]*

*[1] NIST, Boulder, United States*

*[2] Stable Laser Systems, Boulder, United States*

*[3] University of Colorado, Boulder, United States*

We present dispersive dual-comb spectroscopy of atmospheric $CO_2$ across a 2-km open-air path. By sending a single comb through the open-air path, both molecular phase spectrum and conventional absorbance spectrum are obtained. The measured phase spectra match expected molecular lineshape models

ThC-T2-O-06 14:30

**Highly efficient watt level single frequency 780 nm laser**

*Sébastien Vidal, Christophe Pierre, Bruno Chassagne, Pascal Dupriez*

*ALPHANOV Centre Technologique Optique et Laser, Talence, France*

High efficiency generation of a narrow linewidth laser source at 780 nm is reported. 7.6 W is achieved from a compact cavity-enhanced second-harmonic generation seeded with 10 W at 1560 nm. This is the highest continuous power ever reported using a periodically-poled crystal in an external cavity at this wavelength.

ThC-T2-O-07 14:45

**Real-time heterodyned measurements of spatio-frequency dynamics in fibre lasers**

*Srikanth Sugavanam[1], Son Thai Le[1], Simon Fabbri[1], Ivan Lobach[2], Sergey Kablukov[2], Serge Khorev[3], Dmitriy Churkin[1, 2, 4]*

*[1] Aston Institute of Photonic Technologies, Aston University, Birmingham, United Kingdom*

*[2] Institute of Automation and Electrometry SB RAS, Novosibirsk, Russia*

*[3] Zecotek Photonics, Inc, Richmond, Canada*

*[4] Novosibirsk State University, Novosibirsk, Russia*

We demonstrate a real-time spectral measurement technique, combining optical heterodyning with reconstruction of spatio-temporal evolution of radiation inside a fibre laser cavity. Under a slowly varying sinusoid approximation, the fast Fourier transform allows recovery of frequency from the phase domain, providing an improvement in resolution by two orders of magnitude.

ThC-T2-O-08 15:00

**Fibre-based optical parametric oscillator for coherent anti-Stokes Raman spectroscopy**

*Thomas Gottschall[1], Tobias Meyer[2], Benjamin Dietzek[2, 3], Jürgen Popp[2, 3], Jens Limpert[1], Andreas Tünnermann[1, 3], Michael Schmitt[2]*

*[1] Friedrich-Schiller-Universität Jena, Institute of Applied Physics, Abbe Center of Photonics, Albert-Einstein-Str. 15, 07745 Jena, Germany, Jena, Germany*

*[2] Friedrich-Schiller-Universität Jena, Institute of Physical Chemistry, Abbe Center of Photonics, Helmholtzweg 4, 07743 Jena, Germany, Jena, Germany*

*[3] Leibniz Institute of Photonic Technology Jena (IPHT) e.V., Albert-Einstein-Str. 9, 07745 Jena, Germany, Jena, Germany*

*[4] Fraunhofer Institute for Applied Optics and Precision Engineering, Albert-Einstein-Str. 7, 07745 Jena, Germany, Jena, Germany*

A new kind of four-wave mixing based fiber optical parametric oscillator for CARS microscopy has been developed. Spectral bandwidths of only 1 $cm^{-1}$ and peak powers of 4.0 kW and 2.9 kW for CARS pump and Stokes radiation have been achieved with an unprecedented conversion efficiencies of up to 55%.

## Poster Session RE 42 / RE 46

**Poster Session 3 with Coffee Break**
**15:15 - 16:45**

Solid-State Lasers / Fibre and Waveguide Devices

A coffee break will take place at the same time (in the cafeteria).

ThP-T2-P-01

**Micromachined periodically poled $LiNbO_3$ waveguides on Si substrate for second harmonic generation**

*Mathieu Chauvet[1], Florent Bassignot[1], Fabien Henrot[1], Ludovic Gauthier[1], Sylvain Ballandras[2]*

*[1] FEMTO-ST institute, Besançon, France*

*[2] Frec'N'sys, besancon, France*

Periodically poled $LiNbO_3$ optical waveguides with high index contrast reported on silicon substrates have been fabricated by grinding, polishing and precision dicing. The structures show high conversion efficiency in second harmonic generation experiments at telecommunications wavelengths.

ThP-T2-P-02

**High-power ultra-short pulse generation from an Er-doped fiber amplifier**

*Hongjie WANG[1], Leonid Kotov[2], Dmitry Gaponov[1], Mikhail Yashkov[3], Denis Lipatov[3], Mikhail Likhachev[2], Jean-Louis Oudar[4], Sébastien Février[5], Ammar Hideur[1]*

*[1] CORIA - Université de Rouen, Rouen, France*

*[2] FORC - Russian Academy of Sciences, Moscow, Russia*

*[3] ICHPS - Russian Academy of Sciences, Nizhny Novgorod, Russia*

*[4] LPN, Paris, France*

*[5] XLIM - University of Limoges, Limoges, France*

We report on the development of an all-fiber chirped-pulse amplifier system featuring an efficient Yb-free Er-doped large-mode-area fiber. The system is seeded by a chirped-pulse-oscillator and produces 8 W of average output power at 35 MHz repetition rate.

ThP-T2-P-03

**Intermodal Third Harmonic Generation In Germanium-Doped Silica Optical Fiber**

*Adrien Borne[1], Tomotaka Katsura[2], Benoit Boulanger[1], Corinne Félix[1], Patricia Segonds[1], Kamel Bencheikh[3], Juan Ariel Levenson[3]*

*[1] Université Joseph Fourier, Grenoble, France*

*[2] Mitsubishi Electric Corporation, Amagasaki, Japan*

*[3] Laboratoire de Photonique et Nanostructures CNRS, Marcoussis, France*

We performed a full characterization of intermodal third harmonic generation around 515 nm in a germanium-doped silica optical fiber. We evidenced and accurately modeled through a uniaxial symmetry of the third order electric susceptibility the complex polarization behavior involving all the possible phase-matching types that simultaneously occur.

ThP-T2-P-04

**All-fibre dissipative soliton laser oscillator with high pulse energy (>30 nJ) based on single-walled carbon nanotube saturable absorbers**

MAIN CONFERENCE

*Hwanseong Jeong, Sun Young Choi, Fabian Rotermund, Dong-Il Yeom*
*Ajou University, Dept of Physics & Energy Systems Research, Suwon, Korea, Republic of (South)*
We fabricate high quality carbon nano-tube saturable absorber on side-polished fibre with optimized conditon for high power operation of fibre laser. The all-fibre dissipative soliton laser oscillator including our saturable absorber stably delivers laser output pulse width pulse energy of 34 nJ at the average output power of 335 mW

ThP-T2-P-05

**Towards the implementation of large mode area all-glass leakage channel fibres by Sol-Gel silica powder based preform design**

*Jonas Scheuner[1], Manuel Ryser[1], Valerio Romano[1, 2]*
*[1] Universität Bern, Bern, Switzerland*
*[2] Berner Fachhochschule Technik und Informatik, Burgdorf, Switzerland*
Leakage channel fibres are intended to be realised by the sol-gel silica sand method. This procedure allows for great flexibility in the transverse structure. A positioning accuracy of structure elements of 1/10mm is aimed. Furthermore, losses are minimised by the application of a heat treatment of the preform, prior to the drawing.

ThP-T2-P-06

**Saturable absorber based on monolayer graphene deposited on D-shaped fiber for passively mode-locked fiber laser**

*Tao Chen[1], Dongning Wang[1], Changrui Liao[2], Yiping Wang[2]*
*[1] Hong Kong Polytechnic University, Kowloon, Hong Kong*
*[2] College of Optoelectronic Engineering, Shenz hen University, Shenzhen, Guangdong, China*
Monolayer graphene deposited on D-shaped fiber is used as the saturable absorber for passive mode-locked fiber laser operation. The graphene covered on D-shaped fiber allows light-graphene interaction via the evanescent field and the fiber optical power-induced thermal damage can be effectively avoided due to the large length of graphene.

ThP-T2-P-07

**Radiofrequency Impedance Spectroscopy of Laser Fiber Heating**

*Oleg Ryabushkin[1, 2], Renat Shaidullin[1, 2], Ilya Zaytsev[2]*
*[1] Moscow Institute of Physics and Technology, Dolgoprudnyy, Russia*
*[2] Kotelnikov Institute of Radio Engineering and Electronics of RAS, Fryazino, Russia*
Novel method and experimental setup for measurement of active fiber temperature in high-power fiber lasers and amplifiers based on radio frequency impedance spectroscopy are proposed. This method allows determination of the dependence of the temperature distribution along the active fiber on the optical pump power.

ThP-T2-P-08

**All PM fiber dual-wavelength amplifier for Mid-IR radiation generation via DFG processes**

*Karol Krzempek, G. Sobon, J. Sotor, K.M. Abramski*
*Laser & Fiber Electronics Group, Wroclaw University of Technology, Wroclaw, Poland*
We present a method of generating mid-IR radiation via difference frequency generation (DFG) effects occurring in PPLN crystals using an all-PM-fiber dual-wavelength amplifier. The presented mid-IR laser source incorporates an unique all-PM-fiber double-clad (DC) amplifier stage capable of simultaneous amplification of two wavelengths required in the nonlinear DFG process.

ThP-T1-P-09

**Fabrication of tapered fiber bundle couplers for high-power fiber amplifiers**

*Dorota Sliwinska, Pawel Kaczmarek, Krzysztof Abramski*
*Laser and Fiber Electronics Group, Wroclaw University of Technology, Wroclaw, Poland*
In this work, we demonstrate our results on performing (6+1)×1 tapered fiber bundle combiners using a tri-electrode fiber splicing system. In our combiners we have used 9/80 μm single-mode fibers as a signal input ports - this allowed us to reduce the taper ratio and significantly increase the signal transmission.

ThP-T1-P-10

**Monolithic Ytterbium-doped High Power Single Mode Fibre Laser at a Wavelength of 1018 nm**

*Christoph Ottenhues, Thomas Theeg, Katharina Hausmann, Mateusz Wysmolek, Hakan Sayinc, Jörg Neumann, Dietmar Kracht*
*Laser Zentrum Hannover e.V., Hannover, Germany*
We report a monolithic ytterbium-doped high power single mode fibre laser oscillator with an output power of 128W. The oscillator can be used for core-pumping of amplifier systems. An in-house developed WDM combines a seed and a pump signal into one fibre core with a power handling capacity up to 140W.

ThP-T1-P-11

**6 ns passively Q-switched core-pumped fiber laser at 976nm**

*Baptiste Leconte[1], Mathieu Laroche[1], Benoit Cadier[2], Hervé Gilles[1], Sylvain Girard[1], Thierry Robin[2]*
*[1] CIMAP, Caen, France*
*[2] IXFIBER, Lannion, France*
We present a passively Q-switched fiber laser at 976nm using a resonant semiconductor saturable absorber mirror (SESAM) and a double-clad Nd-doped fiber laser emitting at 927nm as pump source. Low time-jitter pulses with duration of 6ns is demonstrated using a short length, highly Yb-doped LMA fiber.

ThP-T1-P-12

**Optimization of Nonlinear Fiber CPA System by Selection of Spectral Region of Operation**

*Julijanas Želudevičius, Kęstutis Regelskis*
*Center for Physical Sciences & Technology, Vilnius, Lithuania*
We investigate numerically optimization prospects of nonlinear fiber CPA system with respect to spectral region of operation (within Yb-doped fiber gain band) and fiber amplifier parameters.

ThP-T1-P-13

**High peak power flexible photonic crystal fiber laser oscillator**

*Avry Shirakov[1, 2], Boris Rosenstein[1], Daniel Belker[1], Amiel Ishaaya[1]*
*[1] Department of Electrical and Computer Engineering, Ben-Gurion University of the Negev, Beer-Sheva 84105, Israel, Beer Sheva, Israel*
*[2] Department of Physics, Ben-Gurion University of the Negev, Beer-Sheva 84105, Israel, Beer Sheva, Israel*
We present an actively Q-switched photonic crystal fiber laser in an oscillator configuration. The laser is based on flexible-type photonic crystal fiber. At a repetition rate of 15 kHz, we obtain pulse energy of 0.6 mJ with pulse duration of 20 ns, and average power of 12 W.

MAIN CONFERENCE

ThP-T1-P-14

**Morphology of nanoholes in borate crystals and glasses fabricated by femtosecond laser ablation**

*Nobuhiro Kodama[1], Tomoko Takahashi[1], Tomomi Sakashirta[1], Tougo Shinonaga[2], Ryosuke Nishi[2], Masahiro Tsukamoto[2], Naoki Ikeda[3], Yoshimasa Sugimoto[3]*

*[1] Akita University, Akita, Japan*

*[2] Osaka University, Osaka, Japan*

*[3] National Insititute for Materials Science, Ibaraki, Japan*

The morphologies of borate crystals and glasses formed by femtosecond laser ablation are investigated with respect to realizing 2D photonic crystals. In addition, the photonic band structures of the fabricated air nanohole arrays are calculated and the electromagnetic wave propagation in arrays containing a line defect (waveguide structures) is examined.

ThP-T1-P-15

**Femtosecond pulsed laser co-deposited Er-Yb monolayer implanted waveguides on silica**

*Jayakrishnan Chandrappan[1], Gin Jose[1], Animesh Jha[1], Tarun Kakkar[1], Matthew Murray[1], Paul Steenson[2]*

*[1] Institute for Materials Research, Faculty of Engineering, University of Leeds, Leeds, United Kingdom*

*[2] Institute of Microwave and Photonics, Electronic and Electrical Engineering, Faculty of E[illegible]ering, University of L[illegible]*

CANCELLED

Mul[illegible]silica planar waveguides are realized with a femtosecond pulsed laser fabrication process. Sequential ablation of rare-earth doped tellurite glasses ($_{79}TeO_2$-$_{10}ZnO$-$_{10}Na_2O$-$_1Er_2O_3$/$_1Yb_2O_3$) results in a 10.3% step change in the effective index. Details of the homogenized metastable $Er^{3+}$-$Yb^{3+}$ co-doped waveguides on silica and the amplifier characteristics will be presented.

ThP-T1-P-16

**2.05-µm continuous-wave Ytterbium-Holmium all-fiber laser pumped at 1.06 µm**

*Alexander Kir'yanov, Vladimir Minkovich, Yuri Barmenkov*

*Centro de Investigaciones en Optica, Leon, Mexico*

An $Yb^{3+}$-$Ho^{3+}$ codoped all-fiber laser oscillating in CW at ~2.05 µm employing a novel pump version, 1.06 µm, is reported. A low laser threshold (<1 W) and moderate slope efficiency of lasing (~7%) are obtained in the simplest non-optimized Fabry-Perot cavity composed of a couple of fiber Bragg gratings.

ThP-T1-P-17

**Actively mode locked fiber laser for synchronized pulsed depletion in STED**

*Shree Krishnamoorthy[1, 2], Satyajit Mayor[2], Anil Prabhakar[1]*

*[1] Indian Institute of technology, Madras, Chennai, India*

*[2] National center for biological sciences, Bangalore, India*

Construction and characterization of a pulsed depletion laser based on actively mode locked fiber laser is shown. It produces time synchronized pulses of <100 ps and jitter below 150 ps when operated with the excitation laser. Optimal operating regimes are observed when wavelength of the excitation laser is swept.

ThP-T1-P-18

**Narrow-Bandwidth Mid-Infrared Optical Parametric Generator Based On $HgGa_2S_4$ Crystal Pumped By 16-ps Pulses At 1064 nm**

*Riccardo Piccoli[1], Federico Pirzio[1], Antonio Agnesi[1], Valeriy Badikov[2], Dmitrii Badikov[2], Georgi Marchev[3], Vladimir Panyutin[3], Valentin Petrov[3]*

*[1] University of Pavia, Laser Source Laboratory, Pavia, Italy*

*[2] High Technologies Laboratory, Kuban State University, Krasnodar, Russia*

*[3] Max-Born-Institute for Nonlinear Optics and Ultrafast Spectroscopy, Berlin, Germany*

We report optical parametric generation based on $HgGa_2S_4$ crystal pumped by 16-ps-long, 250-kHz, 15-µJ pulses at 1064 nm. Extremely wide signal/idler tuning range extending from 1.19 to 1.47 µm and 3.85 to 10 µm respectively was demonstrated. Narrowband, quasi-Fourier-limited, operation was achieved by seed injection at 1.29 µm.

ThP-T1-P-19

**Harnessing frequency combs pumped by multi-mode high-power diodes**

*Alexander Klenner[1], Florian Emaury[1], Andreas Diebold[1], Cinia Schriber[1], Clara J. Saraceno[1, 2], Stéphane Schilt[2], Thomas Südmeyer[2], Ursula Keller[1]*

*[1] Department of Physics, Institute for Quantum Electronics, ETH Zurich, Auguste-Piccard-Hof 1, Zurich, Switzerland*

*[2] Laboratoire Temps-Fréquence, Université de Neuchâtel, Av. de Bellevaux 51, Neuchâtel, Switzerland*

We present carrier-envelope-offset stabilization with low residual phase-noise of a bulk diode-pumped solid-state laser and a thin-disk laser both delivering similar parameters (≈1W, ≈100-fs pulses, ≈100 MHz). This proves that the multi-transverse-mode pumping is not a limitation for stabilized frequency combs, but robust CEO locking relies on appropriate electronic feedback.

ThP-T1-P-20

**Phase-matching properties of the Langatate $La_3Ga_{5.5}Ta_{0.5}O_{14}$ : a new potential nonlinear crystal generating up to 6 µm**

*Elodie Boursier[1], Patricia Segonds[1], Benoit Boulanger[1], Corinne Félix[1], Jérôme Debray[1], David Jegouso[1], Bertrand Ménaert[1], Dmitry Roshchupkin[2], Ichiro Shoji[3]*

*[1] Institut Néel, Centre National de la Recherche Scientifique — Université Joseph Fourier, Grenoble, France*

*[2] Institute of Microelectronics Technology, Russian Academy of Sciences, Chernogolovka, Russia*

*[3] Department of Electrical, Electronic, and Communication Engineering Chuo University Kasuga, Bunkyo-ku, Tokyo, Japan*

We directly measured the phase-matching directions of second harmonic, sum and difference frequency generations of the Langatate crystal LGT. We fitted these data in order to refine the Sellmeier equations, and we showed that it is possible to generate a super continuum in the infrared by pumping LGT with a Ti:Sapphire laser.

ThP-T1-P-21

**Efficient near-infrared laser emission of Pr:$LiYF_4$ at 907 and 915nm**

*Biao Qu[1], Saiyu Luo[1], Bin Xu[1], Huiying Xu[1], Zhipping Cai[1], Patrice Camy[2], Jean-Louis Doualan[2], Richard Moncorgé[2]*

*[1] Xiamen University, Xiamen, China*

*[2] CIMAP-University of Caen, Caen, France*

The presentation reports on the luminescence spectra and the 3P0 to 1G4 laser emission of Pr:$LiYF_4$ at the near-infrared laser wavelengths of 907 and 915nm. An output power of 218 mW with a laser slope efficiency of 24% is obtained for the first time at 915 nm

MAIN CONFERENCE

ThP-T1-P-22

**Crystal growth, spectroscopy, and laser operation of $Pr^{3+}$ in the novel hexagonal laser host material β-$NaGdF_4$**

*Philip Werner Metz[1], Daniel-Timo Marzahl[1], Fabian Reichert[1, 2], Christian Kränkel[1, 2], Günter Huber[1, 2]*

*[1] Institut für Laser-Physik, Universität Hamburg, Hamburg, Germany*

*[2] The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Hamburg, Germany*

We report on the growth and spectroscopic characterization of $Pr^{3+}$-doped β-$NaGdF_4$ crystals. Moreover, we present the first application of β-$NaGdF_4$ as laser host. Laser diode excited laser oscillation of praseodymium was obtained at 608 nm and 642 nm.

ThP-T1-P-23

**Power-scaled laser-diode pumped 747 nm Pr:$YAlO_3$ laser in microchip resonator arrangement**

*Martin Fibrich[1, 2], Jan Šulc[1], Helena Jelínková[1], Michal Němec[1]*

*[1] Czech Technical Universtity in Prague, Prague, Czech Republic*

*[2] Institute of Physics ASCR, Prague, Czech Republic*

Continuous-wave laser operation of 1-W InGaN laser-diode both-side pumped Pr:$YAlO_3$ microchip crystal at room temperature is reported. The microchip geometry was formed by dielectric mirrors directly deposited on the crystal facets. 490 mW of output power at 747 nm with the slope efficiency of 45% has been demonstrated.

ThP-T1-P-24

**Few Cycle Femtosecond OPCPA Front-End based on Picosecond Fiber Laser Seed and Picosecond Solid State Regenerative Amplifier Pump**

*Rokas Danilevičius[1, 2], Rimantas Budriūnas[2, 3], Andrejus Michailovas[1, 2], Nerijus Rusteika[1, 2]*

*[1] Institute of Physics, Center for Physical Sciences and Technology, Vilnius, Lithuania*

*[2] Ekspla Ltd., Vilnius, Lithuania*

*[3] Department of Quantum Electronics, Vilnius University, Vilnius, Lithuania*

In this work we constructed a novel few cycle femtosecond OPCPA front-end. Picosecond all-in-fiber oscillator was used to generate both seed and pump pulses. 10 fs pulses with broadband spectrum around 800 nm were measured at the system output.

ThP-T1-P-25

**Diffraction-limited, high-power pico-second laser formed of a Nd:$YVO_4$/sapphire composite bounce amplifier**

*Masashi Abe[1], Yuta Sasaki[1], Katsuhiko Miyamoto[1], Takashige Omatsu[1, 2]*

*[1] Chiba University, 1-33 Yayoi-cho, Inage-ku, Chib, Japan*

*[2] CREST, 4-1-8 Honcho, Kawaguchi, Saita, Japan*

We demonstrate the diffraction limited (M2<1.1), high average power (>40W), picosecond (~8ps) output from a pico-second master-oscillator and a sapphire end-capped Nd:$YVO_4$ slab bounce amplifier. A corresponding optical-optical efficiency of 53% from the pump laser diode to the picosecond output was achieved.

ThP-T1-P-26

**Efficient actively Q-switched Nd:$KLu(WO_4)_2$ self-Raman laser**

*Zhenhua Cong[1], Zhaojun Liu[1], Xingyu Zhang[1], Huaijin Zhang[2], Jing Li[2], Haohai Yu[2], Xiaohan Chen[1], Zengguang Qin[1], Weitao Wang[1], Ning Li[1], Qiang Fu[1]*

*[1] School of Information Science and Engineering and Shandong Provincial Key Laboratory of Laser Technology and Application,Shandong University, Jinan, China*

*[2] State Key Laboratory of Crystal Materials, Shandong University, Jinan, China*

Abstract: An efficient 1185 nm Nd:$KLu(WO_4)_2$ self-Raman laser was demonstrated for the first time. At pulse repetition frequencies of 10, 15 and 20 kHz, the output power of 1.12 W, 1.32 W and 1.51 W were obtained with conversion efficiencies of 8.86%, 9.16% and 9.78%, respectively.

ThP-T1-P-27

**2 μm ytterbium-sensitized $Tm^{3+}$:$CaF_2$ laser pumped at 980 nm**

*Jean-Louis Doualan, Alain Braud, Abdelmjid Benayad, Vivien Ménard, Richard Moncorgé, Patrice Camy*

*Centre de recherche sur les Ions, les Matériaux et la Photonique (CIMAP), UMR CNRS-CEA-Ensicaen, Universite de Caen, 6 Boulevard Maréchal Juin, F-14050 Caen, France, CAEN, France*

Laser operation around 2 μm is reported with a Yb:Tm:$CaF_2$ crystal pumped at 980 nm. The maximum output power is 138 mW, and the slope efficiency obtained with an output coupler having a transmission of 1.8% is 17% with respect to the incident pump power.

ThP-T1-P-28

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

*Kirilas Michailovas[1], Andrejus Michailovas[1, 2], Audrius Zaukevicius[1], Valerijus Smilgevicius[3]*

*[1] EKSPLA, Vilnius, Lithuania*

*[2] Center for Physical Sciences and Technology, Vilnius, Lithuania*

*[3] VU Laser Research Center, Vilnius, Lithuania*

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

ThP-T1-P-29

**Development of a 20 mJ, 1050 nm diode-pumped Yb:$CaF_2$/YAG amplifier for seeding a 10-level TW Nd:glass laser**

*Celso João, Hugo Pires, Gonçalo Figueira*

*Instituto de Plasmas e Fusão Nuclear, Lisbon, Portugal*

We report a 20 mJ diode-pumped, double-stage CPA laser amplifier operating at 1050 nm, fully based on Yb-doped gain media. The system consists of a 3 mJ Yb:$CaF_2$ regenerative amplifier and a 20 mJ, eight passes Yb:YAG amplifier and is designed to seed a 10-level TW Nd:glass laser.

ThP-T1-P-30

**A continuous-wave vortex Raman laser producing wavelength-selectable visible emission**

*Andrew Lee*

*Macquarie University, North Ryde, Australia*

We report a continuous wave vortex Raman laser which produces wavelength-selectable output in the visible, operating with vortex fundamental and Stokes fields. Using processes of intracavity second harmonic generation and sum-frequency generation, we produce 1.2W emission at 532nm, 0.9W at 559nm, and 0.7W at 586nm.

ThP-T1-P-31

**Pulsed $KGd(WO_4)_2$ Raman laser: towards emission linewidth narrowing**

*Vasili Savitski*

*Institute of Photonics, University of Strathclyde, Glasgow, United Kingdom*

The linewidth of a $KGd(WO_4)_2$ pulsed Raman laser is analysed experimentally for different configurations of the Raman and pump resonators. The benefits of a narrow linewidth pump source in combination with

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linewidth narrowing elements in the Raman laser cavity for the efficient linewidth narrowing of the Raman emission are explained.

ThP-T1-P-32

**Iterative numerical investigation of the thermal dephasing process in second harmonic generation in bulk periodically-poled crystals**

***Staffan Tjörnhammar, Peter Zeil, Valdas Pasiskevicius, Fredrik Laurell***

*Laser physics, KTH Royal Institute of Technology, Stockholm, Sweden*

We numerically study the detrimental effect of thermal dephasing during second-harmonic generation in quasi-phase matched materials by iteratively solving the coupled wave eqations and the heat transfer equation. The variation of different experimental conditions, such as external phase-match temperature and focussing conditions is discussed.

ThP-T1-P-33

**Development of CW seeded picosecond mid-IR parametric light source pumped by the high-average-power Yb:YAG thin-disk laser**

***Ondrej Novak[1], Martin Smrz[1], Taisuke Miura[1], Jaroslav Huynh[1, 2], Akira Endo[1], Tomas Mocek[1]***

*[1] HiLASE Project & Department of Diode-pumped Lasers, Institute of Physics AS CR, v.v.i., Prague, Czech Republic*

*[2] Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, Prague, Czech Republic*

Development of high-average power CW seeded picosecond mid-IR parametric light source will be presented. The output of the developed 100 kHz thin-disk based regenerative amplifier of 75-W average power is used for pumping. The seeded OPG in the PPLN crystal and its amplification in the KTP crystal will be described.

ThP-T1-P-34

**Thermal lensing in Tm:KLu($WO_4$)$_2$ laser crystals cut along the optical indicatrix axes**

***Pavel Loiko[1], Josep Maria Serres[2], Xavier Mateos[2], Konstantin Yumashev[1], Nikolai Kuleshov[1], Valentin Petrov[3], Uwe Griebner[3], Magdalena Aguilo[2], Francesc Diaz[2]***

*[1] Center for Optical Materials and Technologies, Belarusian National Technical University, Minsk, Belarus*

*[2] Física i Cristal•lografia de Materials i Nanomaterials (FiCMA-FiCNA), Universitat Rovira i Virgili, Tarragona, Spain*

*[3] Max-Born-Institute for Nonlinear Optics and Short Pulse Spectroscopy, Berlin, Germany*

A comparative experimental study of thermal lensing is performed for monoclinic Tm:KLu($WO_4$)$_2$ laser crystals cut along the p, m and g optical indicatrix axes. Ng-cut crystal with a pure positive and near-spherical thermal lens allows us to realize quasi-monolithic Tm:KLu($WO_4$)$_2$ "microchip" laser.

ThP-T1-P-35

**Cryogenic spectroscopy of Yb:YGAG ceramic for high energy short pulse lasers**

***Venkatesan Jambunathan[1], Lucie Těsnohlídková[1, 2], Taisuke Miura[1], Akira Endo[1], Jan Sulc[2], Helena Jelínková[2], Antonio Lucianetti[1], Tomas Mocek[1]***

*[1] HiLASE center, Institute of Physics AS CR, v.v.i.,, Dolní Brezany, Czech Republic*

*[2] Czech Technical University in Prague, Brehová 7, 11519, Prague, Czech Republic*

We present here the cryogenic spectroscopy of Yb doped Yttrium gallium aluminum mixed garnet ceramic (Yb:YGAG). The emission bandwidth of Yb:YGAG is three times higher than that of Yb:YAG at cryogenic temperatures which makes this material promising for the generation of short pulses.

ThP-T1-P-36

**Beam profiling of infrared lasers with silicon CCDs by active wavelength up-conversion**

***Adrian J. Torregrosa[1], Haroldo Maestre[1], Maria Luisa Rico[2], Juan Capmany[1]***

*[1] Department of Communications Engineering. Miguel Hernandez University, Elche, Spain*

*[2] Department of Computer Technology. University of Alicante., Alicante, Spain*

We present an active wavelength conversion system from infrared eye-safe optical beams around 1550 nm to the visible spectrum for their spatial characterization with standard silicon CCD or CMOS cameras based on nonlinear optical sum-frequency mixing with a 1064 nm beam of a diode-pumped $Nd^{3+}$:$YVO_4$ solid state laser

ThP-T1-P-37

**Infrared Femtosecond Optical Parametric Oscillator Using PPLN and MgO:PPLN Crystals Synchronously Pumped by Yb:KGW Laser**

***Ieva Pipinytė[1], Karolina Stankevičiūtė[1], Rimantas Grigonis[1], Robert Eckardt[2], Valdas Sirutkaitis[1]***

*[1] Laser Research Center, Vilnius University, Sauletekio ave. 10, LT-10223, Vilnius, Lithuania*

*[2] Gooch and Housego (Ohio), 676 Alpha Drive, Highland Hts, Ohio, United States*

The efficient operation of the optical parametric oscillator, synchronously pumped by fundamental radiation (1030 nm) of Yb:KGW laser, providing 105 fs pulses at 76 MHz repetition rate was demonstrated. We used PPLN and MgO:POLN crystals and obtained maximum efficiency >24 % in 1436 – 1463 nm signal spectrum range.

## Aula des Jeunes-Rives

**Crystalline-host Lasers - 16:45 - 18:45**
**Solid-State Lasers**

***Chaired by: Majid Ebrahim-Zadeh**, ICFO - The Institute of Photonic Sciences, Barcelona, Spain*

ThD-T1-I-01 (Invited) 16:45

**Micro Domain-controlled Laser Materials Toward Giant Micro-photonics**

***Takunori Taira***

*Laser Research Center for Molecular Science, Institute for Molecular Science, Okazaki, Japan*

The past decade has witnessed a veritable revolution in the types and performance levels of solid-state lasers, largely due to development of micro-domain engineered new optical materials: micro-domain structured transparent laser ceramics and ferroelectrics for quasi-phase matched nonlinear optics. We'd like to discuss the capabilities of Giant Micro-photonics for energy.

ThD-T1-O-02 17:15

**Direct measurement of the dielectric frame rotation in monoclinic crystals as a function of the wavelength**

***Patricia Loren Inacio[1], Christian Traum[1], Corinne Félix[1], Patricia Segonds[1], Benoît Boulanger[1], Jérôme Debray[1], Alexandra Peña[1], Yannick Petit[2], Daniel Rytz[3], Germano Montemezzani[4], Philippe Goldner[5], Alban Ferrier[5]***

*[1] Institut Néel, CNRS – Université J. Fourier, Grenoble, France*

*[2] Institut de la Chimie et de la Matière Condensée de Bordeaux (ICMCB), CNRS Université Bordeaux, Bordeaux, France*

*[3] FEE GmbH, Struthstr, Idar-Oberstein, Germany*

*[4] Laboratoire Matériaux Optiques, Photonique et Systèmes (LMOPS), Université de Lorraine and Supélec, Metz, France*

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[5] Laboratoire de Chimie de la Matière Condensée de Paris (LCMCP) - CNRS, ENSCP, Paris, France

We describe a method never implemented before and enabling the direct measurement of the dielectric frame rotation of monoclinic crystals. It has the advantage to use slabs and was validated in $Nd^{3+}$:YCa4O$(BO_3)_3$, $Sn_2P_2S_6$, and $BiB_3O_6$. We also report for the first time a dielectric frame rotation of 3° in $Eu^{3+}$:$Y_2SiO_5$.

ThD-T1-O-03 17:30

**Spectroscopy, continuous-wave and Q-switched operation of a 2.04 µm Ho:$KY_3F_{10}$ laser**

***Daniela Parisi*[1], *Martin Schellhorn*[2], *Marc Eichhorn*[2], *Mauro Tonelli*[1, 3]**

[1] NEST Istituto Nanoscienze– CNR piazza S. Silvestro12 , I - 56127 Pisa, Italy, Pisa, Italy

[2] French-German Research Institute, ISL, 5, rue du General Cassagnou, 68301 Saint-Louis, France, Saint-Louis, France

[3] Dipartimento di Fisica Università di Pisa, Largo B. Pontecorvo 3, I - 56127 Pisa, Italy, Pisa, Italy

We report on the growth, spectroscopy and laser emission of a Ho:$KY_3F_{10}$ crystal. A maximum laser power of 7.8W was obtained corresponding to a slope efficiency of 60.7% with respect to absorbed power. At 10kHz 0.78mJ energy per pulse was demonstrated with pulse widths of 100ns.

ThD-T1-O-04 17:45

**Mid-infrared lasing from $Ho^{3+}$ in bulk $InF_3$ glass and BYF crystal.**

***Antoine Berrou*, *Christelle Kieleck*, *Marc Eichhorn***

*French-German Research Institute of Saint-Louis (ISL), Saint-Louis, France*

First bulk lasing around 4 µm of holmium-doped InF3-based glass and a comparison to a BYF crystal is reported. BYF shows a lower threshold and a higher slope efficiency than InF3 glass. At 650 mJ pump energy, 35 mJ (5.4 mJ) was obtained with BYF ($InF_3$), respectively.

ThD-T1-O-05 18:00

**1.2 mJ, 1 kHz, ps- pulses at 2.05 µm from a Ho:fibre / Ho:YLF laser**

***Krishna Murari*[1], *Huseyin Chankaya*[1], *Peng Li*[1], *Axel Ruehl*[1], *Ingmar Hartl*[1], *Franz Kaertner*[1, 2]**

[1] Deutsches Elektronen-Synchrotron (DESY), Notkestrasse 85, 22607 Hamburg, Germany, Hamburg, Germany

[2] Department of Electrical Engineering and Computer Science and Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA, Boston, United States

We demonstrate a compact 1.1-mJ, 3.5-ps 2050-nm source composed of a passively modelocked Ho:fiber seed laser followed by a Ho:YLF regenerative amplifier and single-pass amplifier. Stretching and compression is achieved via chirped volume bragg gratings. A fused quartz-etalon in the regenerative amplifier shortens the pulse duration 2.5 ps.

ThD-T1-O-06 18:15

**Highest power and Q-switched diode end-pumped Alexandrite laser**

***Michael Damzen*[1], *Achaya Teppitaksak*[1], *Gabrielle Thomas*[1], *Ara Minassian*[2]**

[1] The Blackett Laboratory, Imperial College London, London, United Kingdom

[2] Unilase Ltd, London, United Kingdom

Highest power (>26W) and slope efficiency (49%) demonstrated from a diode-end-pumped Alexandrite rod laser, as well as external grating tuning from 730 – 792nm, and first Q-switched demonstration with 0.74mJ pulses at 1kHz in TEM00 mode, showing exciting prospects for efficient low-cost remote sensing and ultrafast (*e.g.* biophotonic) applications.

ThD-T1-O-07 18:30

**290 W fiber-laser-pumped diamond Raman laser**

***Robert Williams*[1], *Ondrej Kitzler*[1], *Johannes Nold*[2], *Max Strecker*[2], *Aaron McKay*[1], *Thomas Schreiber*[2], *Richard Mildren*[1]**

[1] MQ Photonics Research Centre, Department of Physics and Astronomy, Macquarie University, North Ryde, Australia

[2] Fraunhofer Institute of Applied Optics and Precision Engineering, Jena, Germany

We use long-pulse pumping to investigate power-scaling of diamond Raman lasers. Thermal gradients reach steady-state within the pulse duration of quasi-cw Nd:YAG technology (<100 µs). Using this approach, and high-power fiber amplifier technology, we demonstrate record output powers up to 290 W for pulse durations up to 10 ms.

## Cafeteria

**Refreshments - 18:45 - 19:15**

## Aula des Jeunes-Rives

**Post-Deadlines - 19:15 - 20:00**
**Solid-State Lasers**

***Chaired by: Thomas Südmeyer**, University of Neuchâtel, Neuchâtel, Switzerland*

ThE-T1-O-01 19:15

**Mechanical phase matching of birefringent non-linear crystals**

***Loïc Deyra*[1], *François Balembois*[1], *André Guilbaud*[1], *Philippe Villeval*[2], *Patrick Georges*[1]**

[1] Laboratoire Charles Fabry, UMR 8501, Institut d'Optique, CNRS, Univ Paris Sud, Palaiseau, France

[2] Cristal Laser, Messein, France

We demonstrate a new concept called "mechanical phase-matching", based on the strong mechanical compression of a nonlinear crystal. We successfully tuned the second harmonic non-critical phase matching wavelength of $LiB_3O_5$ (LBO) crystal at room temperature from 1200 nm to 1120 nm by applying compressive forces up to 100 MPa.

ThE-T1-O-02 19:30

**Ti:sapphire-pumped, deep-infrared, intracavity-cascaded femtosecond optical parametric oscillator**

***Venkata Ramaiah-Bardarla*[1], *Adolfo Esteban-Martin*[1], *S. Chaitanya Kumar*[1], *Kavita Devi*[1], *Kevin Zawilski*[2], *Peter Schunemann*[2], *Majid Ebrahim-Zadeh*[1, 3]**

[1] ICFO-The Institute of Photonic Sciences, Mediterranean Technology Park, 08860 Castelldefels, Barcelona, Spain, Castelldefels, Spain

[2] BAE Systems, Inc., MER15-1813, P.O. Box 868, Nashua, New Hampshire 03061-0868, USA, Nashaua, United States

[3] Institucio Catalana de Recerca i Estudis Avancats (ICREA), Passeig Lluis Companys 23, Barcelona 08010, Spain, Barcelona, Spain

We report the first femtosecond OPO for the deep-IR synchronously-pumped by a Ti:sapphire laser. Using a novel intracavity-cascaded pumping technique deploying PPLN in combination with $CdSiP_2$, femtosecond pulses with continuous coverage across 5500-8500 mm are generated under rapid static cavity delay tuning with high output stability at room temperature.

ThE-T1-O-03 19:45

**CEP-Stable, Few-Cycle OPCPA System with more than 15 W of Average Output Power at 300 kHz**

***Marcel Schultze[1], Stephan Prinz[1, 2], Catherine Y. Teisset[1], Matthias Haefner[1], Robert Bessing[1], Knut Michel[1], Thomas Metzger[1]***
*[1] TRUMPF Scientific Lasers, Unterföhring, Germany*
*[2] Technische Unversität München, München, Germany*

We present a CEP-stable, two-stage OPCPA system delivering more than 15 W of compressed output power with pulse durations below 6 fs at 300 kHz repetition rate. The system is based on a broadband CEP-stabilized Ti:Sapphire oscillator and an optically synchronized thin-disk regenerative amplifier.

# Friday Sessions

## Aula des Jeunes-Rives

### Fiber Sources for High-field Experiments - 08:00 - 10:00 Fibre and Waveguide Devices

***Chaired by: Aleksei Zheltikov**, Moscow State University, Moscow, Russia*

FrA-T2-I-01 (Invited) 08:00

**Extreme Nonlinear Optics with Kagome Hollow-core PCF**

***Fetah Benabid***
*University of Limoges, Xlim Research Institute, CNRS UMR 7252, GPPMM Group, Limoges, France*

We review the recent progress on hypocycloid-shaped core-contour (*i.e.* negative curvature) hollow-core photonic-crystal-fibre and its implementation for the first time in the fields of micro-wave plasma, whereby a highly stable fibre-confined argon plasma column is generated, and of high optical-fields, where a femtosecond pulse was self-compressed to the sub-cycle cycle regime.

FrA-T2-O-02 08:30

**Generation of sub-10 fs, 0.4 mJ pulses at 100 kHz repetition rate**

***Jan Rothhardt[1, 2], Steffen Hädrich[1, 2], Arno Klenke[1, 2], Stefan Demmler[1], Tino Eidam[1], Armin Hoffmann[1], Jens Limpert[1, 2], Andreas Tünnermann[1, 2]***
*[1] Institute of Applied Physics, Friedrich-Schiller Universität Jena, Jena, Germany*
*[2] Helmholtz Institut Jena, Jena, Germany*

We present a laser system generating intense few-cycle pulses based on two-stage hollow-fiber compression of ultrashort pulses delivered by a high power fiber laser. We obtain pulses as short as 7.8 fs, with 380 µJ pulse energy at 100 kHz repetition rate.

FrA-T2-O-03 08:45

**Strong field applications of Gigawatt self-compressed pulses from a Kagome fiber**

***Guangyu Fan***
*Photonics Institute, Vienna University of Technology, vienna, Austria*
*GPPMM group, Xlim Research Institute, CNRS UMR 7252, University of Limoges, Limoges, France*
*Blackett Laboratory, Imperial College London, London, United Kingdom*
*M.V. Lomonosov Moscow State University, Moscow, Russia*
*Department of Physics and Astronomy, Texas A&M University, Texas, United States*
*Institute of Optics and Quantum Electronics, Jena, Jena, Germany*

We demonstrate efficient self-compression of 1.7µm infrared pulses to quasi-single cycle duration with sustained 100µJ level pulse energies in an ultra-broadband Kagome-lattice hollow-core photonic crystal fibre (HC-PCF). To demonstrate applicability of this compact single-cycle source, we launched ATI electron spectrometry measurements and driving high-order harmonic generation.

FrA-T2-O-04 09:00

**Pulse compression at 100 W of average power using gas-filled Kagome-type HC-PCF**

***Florian Emaury[1], Clara Saraceno[1, 2], Benoit Debord[3], Cie Fourcade-Dutin[3], Frédéric Gerome[3], Thomas Südmeyer[2], Fetah Benabid[3], Ursula Keller[1]***
*[1] ETH Zürich, Zürich, Switzerland*
*[2] University of Neuchâtel, Neuchâtel, Switzerland*
*[3] University of Limoges, Limoges, France*

We demonstrate that Kagome-type HC-PCFs are suitable for femtosecond pulse compression at 100W average power level. We compressed a high-energy SESAM-modelocked thin-disk laser using an Ar-filled Kagome-type HC-PCF: launching 41-µJ, 1.17-ps pulses directly from the oscillator, we obtain 179-fs pulses at 100W of average power, reaching 80% overall compression efficiency.

FrA-T2-O-05 09:15

**High peak-power monolithic femtosecond ytterbium fiber chirped pulse amplifier with a spliced-on hollow core fiber compressor**

***Aart Verhoef[1], Kim Jespersen[2], Thomas Andersen[2], Lars Grüner-Nielsen[3], Tobias Flöry[1], Lingxiao Zhu[1, 4], Andrius Baltuska[1], Alma Fernández[1]***
*[1] Photonics Institute, TU Wien, Wien, Austria*
*[2] NKT Photonics A/S, Birkerød, Denmark*
*[3] OFS Denmark, Brøndby, Denmark*
*[4] University of Vienna, Wien, Austria*

A monolithic Yb-fiber chirped pulse amplifier with a spliced-on hollow-core photonic bandgap fiber compressor is presented. The end-facet of the amplifier and entrance facet of the compressor are cleaved with corresponding angles minimizing back-reflection. 226 fs pulses with an energy of 135 nJ are achieved.

FrA-T2-O-06 09:30

**Nonlinear compression of a femtosecond fiber chirped pulse amplifier in hypocycloid core Kagome fiber**

***Florent Guichard[1, 2], Yoann Zaouter[2], Marc Hanna[1], Benoït Debord[4], Frederic Gerome[4, 5], Pascal Dupriez[3], Clemens Hönninger[2], Eric Mottay[2], Fetah Benabid[4, 5], Patrick Georges[1]***
*[1] Laboratoire Charles Fabry, Palaiseau, France*
*[2] Amplitude Systèmes, Pessac, France*
*[3] Alphanov, Talence, France*
*[4] GPPMM group, Limoges, France*
*[5] GLOphotonics, Limoges, France*

We demonstrate the nonlinear compression of a fiber chirped-pulse amplifier in an air-filled hypocycloid core Kagome fiber. The unique properties of such fiber allow us to generate 100 fs pulses with an energy of more than 200 µJ together with exceptional overall-transmission efficiency of 90 %.

FrA-T2-O-07 09:45

**18GW peak-power femtosecond fiber CPA system**

***Arno Klenke[1, 2], Jan Rothhardt[1, 2], Tino Eidam[1, 2], Stefan Demmler[1], Marco Kienel[1, 2], Thomas Gottschall[1], Steffen Hädrich[1, 2], Jens Limpert[1, 2], Andreas Tünnermann[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 of Applied Optics and Precision Engineering, Jena, Germany*

We present a femtosecond fiber CPA system based on the combination of a broadband stretcher, an advanced fiber design and the coherent combination of three main amplifiers. With this system we were able to generate 200fs pulses with more than 18GW of peak-power and a high combination efficiency.

## Cafeteria

**Coffee Break - 10:00 - 10:30**

## Aula des Jeunes-Rives

**Semiconductor and Microchip Lasers - 10:30 - 12:30**
**Solid-State Lasers**
***Chaired by: Alphan Sennaroğlu**, Koç University, Istanbul, Turkey*

FrB-T1-O-01 10:30

**Recent advances in ultrafast MIXSELs**
***Mario Mangold, Christian Zaugg, Alexander Klenner, Sandro Link, Aline Mayer, Matthias Golling, Bauke Tilma, Ursula Keller***
*Institute for Quantum Electronics, Department of Physics, ETH Zurich, Zurich, Switzerland*
We present a modelocked integrated external-cavity surface emitting laser (MIXSEL) which combines 570-fs-pulses and repetition rate scalability from 5 GHz to record high 101 GHz at >100 mW average output power. Additionally, we achieve record low timing jitters and excellent amplitude noise of a free-running and piezo-stabilized high-power picosecond MIXSEL.

FrB-T1-O-02 10:45

**High Power Wafer-Fused Flip Chip Semiconductor Disk Laser at 1.27 µm**
***Antti Rantamäki[1], Alexei Sirbu[2], Esa Saarinen[1], Jari Lyytikäinen[1], Vladimir Iakovlev[2], Eli Kapon[2], Oleg Okhotnikov[1]***
*[1] Optoelectronics Research Centre, Tampere University of Technology, Tampere, Finland*
*[2] École Polytechnique Fèdèrale de Lausanne, Lausanne, Switzerland*
We present 5.6 W of output power from a flip chip semiconductor disk laser emitting in the 1.3 µm waveband. This is the first demonstration of a flip chip semiconductor disk laser at this wavelength range with output powers comparable similar SDLs with intracavity diamond heat spreaders.

FrB-T1-O-03 11:00

**Efficient Microchip Continuous-wave and Q-switched Thulium laser**
***Maxim Gaponenko[1], Nikolay Kuleshov[2], Thomas Südmeyer[1]***
*[1] Laboratoire Temps-Fréquence, Université de Neuchâtel, Neuchâtel, Switzerland*
*[2] Center for Optical Materials and Technologies, BNTU, Minsk, Belarus*
We present a 1.9-µm Tm:KY$(WO_4)_2$ microchip laser with 1-W continuous-wave output power in a TEM00 mode with 71% slope efficiency relative to the absorbed pump radiation and 43% optical-to-optical efficiency. 2.4-ns pulses at a repetition rate of 1.2-MHz are achieved in a Q-switched operation.

FrB-T1-O-04 11:15

**3.2 W output power of a diode-pumped Tm:KLu$(WO_4)_2$ microchip laser**
***Xavier Mateos[1], Josep Maria Serres[1], Pavel Loiko[2], Konstantin Yumashev[2], Nikolai Kuleshov[2], Valentin Petrov[3], Uwe Griebner[3], Magdalena Aguiló[1], Francesc Díaz[1]***
*[1] Física i Cristal·lografia de Materials i Nanomaterials (FiCMA-FiCNA), Universitat Rovira i Virgili (URV), Campus Sescelades, c/ Marcel·lí Domingo, s/n., Tarragona, Spain*
*[2] Center for Optical Materials and Technologies, Belarusian National Technical University, 65/17 Nezavisimosti Ave., Minsk, Belarus*
*[3] Max Born Institute for Nonlinear Optics and Short Pulse Spectroscopy, 2A Max-Born-Str., Berlin, Germany*
TEM00-mode laser operation with output power higher than 3 W at 1946 nm is demonstrated in a Ng-cut Tm:KLuW microchip laser. We computed and analyzed the mode-matching and cavity stability of the Tm:KLuW microchip laser with respect to the thermo-optic effects and expect further power scaling.

FrB-T1-O-05 11:30

**Highly efficient cw and mode-locked OPSL-pumped Yb:$Lu_2O_3$-lasers**
***Alexander Heuer[1], Kolja Beil[1], Christian Kränkel[1, 2]***
*[1] Institut für Laser-Physik, Universität Hamburg, Hamburg, Germany*
*[2] The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Hamburg, Germany*
We report on an OPSL pumped Yb-doped lutetia laser. In cw mode an output power of 5.75 W was realized in diffraction limited beam quality. In mode-locked operation 1.22 W of average output power at a very high optical efficiency of 60% were obtained in 468-fs pulses.

FrB-T1-O-06 11:45

**Red Praseodymium Laser Passively Mode-Locked with a GaInP SESAM**
***Maxim Gaponenko[1], Philip Metz[2], Antti Härkönen[3], Alexander Heuer[2], Tomi Leinonen[3], Mircea Guina[3, 4], Thomas Südmeyer[1], Günter Huber[2, 5], Christian Kränkel[2, 5]***
*[1] Laboratoire Temps-Fréquence, Université de Neuchâtel, Neuchâtel, Switzerland*
*[2] Institut für Laser-Physik, Universität Hamburg, Hamburg, Switzerland*
*[3] Optoelectronics Research Centre, Tampere University of Technology, Tampere, Finland*
*[4] RefleKron Ltd., Tampere, Finland*
*[5] The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Hamburg, Germany*
We report on the first SESAM mode-locked praseodymium laser. Stable self-starting continuous-wave mode locking operation was realized at a wavelength of 639.5 nm with an output power of 12 mW and a pulse repetition rate of 85.6 MHz.

FrB-T1-O-07 12:00

**Efficient green and yellow lasers in Tb3+ doped $LiYF_4$, $LiLuF_4$, and $KY_3F_{10}$ crystals**
***Philip Werner Metz[1], Christian Kränkel[1, 2], Günter Huber[1, 2]***
*[1] Institut für Laser-Physik, Universität Hamburg, Hamburg, Germany*
*[2] The Hamburg Centre for Ulrafast Imaging, Universität Hamburg, Hamburg, Germany*
Efficient 2ω-OPSL pumped cw laser operation of $Tb^{3+}$ in $LiYF_4$, $LiLuF_4$, and $KY_3F_{10}$ at 545 nm and 585 nm with low threshold is reported. Up to 55% slope efficiency with 176 mW of maximum output power were obtained from $Tb^{3+}$:$LiYF_4$.

FrB-T1-O-08 12:15

**Wide wavelength tuning of laser diode pumped $Pr^{3+}$-lasers in $LiYF_4$, $KY_3F_{10}$, and $BaY_2F_8$ crystals**
***Philip Werner Metz[1], Daniel-Timo Marzahl[1], Fabian Reichert[1], Daniela Parisi[2], Mauro Tonelli[2], Günter Huber[1, 3], Christian Kränkel[1, 3]***
*[1] Institut für Laser-Physik, Universität Hamburg, Hamburg, Germany*
*[2] NEST-Istituto Nanoscience-CNR and Dipartimento di Fisica, Università di Pisa, Pisa, Italy*
*[3] The Hamburg Centre for Ultrafast Imaging, Universität Hamburg, Hamburg, Germany*
We report on wavelength tuning with laser diode pumped $Pr^{3+}$-doped fluoride crystals. The largest total tuning range exceeded 100 nm on several intervals between 521 nm and 737 nm was addressed with KYF under q-cw excitation. Similar tuning ranges were obtained with BYF and YLF in true cw.

## Authors' Index

**NOTES**

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