Short Time-scale Physics and Applied Laser Physics Division
Fachverband Kurzzeit- und angewandte Laserphysik (K)

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Overview of Invited Talks and Sessions

(Lecture halls f428; Poster Empore Lichthof)

Invited Talks

K 1.1	Mon	14:00–14:45	f428	**Zeit, Raum und Information in der physikalischen Beschreibung** — •Rudolf Germer

Invited talks of the joint symposium SYAI

See SYAI for the full program of the symposium.

SYAI 1.1	Mon	14:00–14:30	e415	**Atom interferometry and its applications for gravity sensing** — •Franck Pereira dos Santos, Luc Absil, Romain Caldani, Xiaobing Deng, Romain Karcher, Sébastien Merlet, Raphaël Piccon, Sumit Sarkar
SYAI 1.2	Mon	14:30–15:00	e415	**Atom interferometry for advanced geodesy and gravitational wave observation** — •Philippe Bouyer
SYAI 1.3	Mon	15:00–15:30	e415	**Fundamental physics with atom interferometry** — •Paul Hamilton
SYAI 1.4	Mon	15:30–16:00	e415	**Atoms and molecules interacting with light** — •Lucia Hackermüller

Invited talks of the joint symposium SYAD

See SYAD for the full program of the symposium.

SYAD 1.1	Tue	11:00–11:30	e415	**Electron Pulse Control with Terahertz Fields** — •Dominik Ehberger
SYAD 1.2	Tue	11:30–12:00	e415	**Laser-Based High-Voltage Metrology with ppm Accuracy** — •Kristian König, Christopher Geppert, Phillip Imgram, Jörg Krämer, Bernhard Maass, Johann Meisner, Ernst Otten, Stephan Passon, Tim Ratajczyk, Johannes Ullmann, Wilfried Nörtershäuser
SYAD 1.3	Tue	12:00–12:30	e415	**Structured singular light fields** — •Eileen Otte
SYAD 1.4	Tue	12:30–13:00	e415	**Coherent Coupling of a Single Molecule to a Fabry-Perot Microcavity** — •Daqing Wang

Sessions

K 1.1–1.6	Mon	14:00–16:00	f428	**New Methods - Detonic - Light sources (EUV and others)**
K 2.1–2.7	Tue	14:00–15:45	f428	**Laser Systems**
K 3	Tue	15:45–16:00	f428	**Annual General Meeting**
K 4.1–4.13	Tue	16:30–18:30	f428	**Poster**
K 5.1–5.7	Wed	11:00–12:45	f428	**Laser Systems and Laser Applications**
K 6.1–6.1	Wed	13:10–13:55	f303	**Lunch talk: German Research Foundation (DFG) (joint session A/K/P/MO/MS/Q)**
K 7.1–7.4	Wed	14:00–15:00	f428	**Laser Beam Interaction and Laser Diagnostics**

Annual General Meeting of the Short Time-scale Physics and Applied Laser Physics Division

Dienstag 15:45–16:00 f428

- Bericht

- Verschiedenes

K 1: New Methods - Detonic - Light sources (EUV and others)

Time: Monday 14:00–16:00 Location: f428

Invited Talk K 1.1 Mon 14:00 f428

Zeit, Raum und Information in der physikalischen Beschreibung — •Rudolf Germer — ITPeV, TU-Berlin

Wenn man mit Photonen die Struktur des Wasserstoffatoms erfassen möchte, braucht man für das Freisetzen des Elektrons aus dem Grundzustand 1s die Ionisationsenergie. Ein entsprechendes Photon hat eine Wellenlänge, die dem Orbitalumfang von 1s proportional ist. Im zweiten Orbital beträgt die Ionisationsenergie nur noch * der des Grundzustands und die linearen Abmessungen des Orbitales sind viermal so groß. Neben dem s-Zustand gibt es nun allerdings noch die drei p-Orbitale. Eine geringere räumliche Präzision ist gekoppelt mit einer größeren Anzahl von Möglichkeiten; der Energieaufwand, alle abzutasten, bleibt bei diesem und auch den folgenden Orbitalen immer gleich. Dies spricht dafür, Informationsbausteine als eine physikalische Größe in Betracht zu ziehen. Die Bits sind dann die abzählbaren Wirkungsquanten h und Maßstab und Genauigkeit werden durch die Energie E repräsentiert. Das Wasserstoffatom ist dann ein Repräsentant kleinster Informationsmenge mit dem Elektron und dem Proton und ihrer Beziehungen zueinander. Bei N Photonen gilt E=N*h*c/l. Information tritt nun nicht nur lokal atomisiert auf, sondern auch bei großen Gruppen in kollektiver Form. Zeitkonstanten der Fluoreszenz sind mit einmaligen Vorgängen nicht zu erfassen. Aber mit einer Gruppe gleichzeitig angeregter räumlich verteilter Fluoreszenzzentren ist die Halbwertszeit zu bestimmen genauso wie mit einem einzelnen lokalisierten Atom bei zahlreichen über einen Zeitbereich verteilten Anregungen. germer@physik.tu-berlin.de

K 1.2 Mon 14:45 f428

Materialbeanspruchung bei druckfesten Kapselungen — •Stefanie Spörhase[1], Falk Marian Brombach[1], Detlev Markus[1], Otto Walch[2] und Tim Krause[1] — [1]Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany — [2]R. STAHL Schaltgeräte GmbH, Waldenburg, Germany

Zur Prävention von Explosionen bei elektrischen Betriebsmitteln in explosionsgefährdeten Bereichen kann die Zündschutzart "Druckfeste Kapselung" angewendet werden. Bei der Zertifizierung solcher Gehäuse kann die Überdruckprüfung zum Nachweis der Druckfestigkeit entweder statisch oder dynamisch erfolgen. Dabei wird allein der geglättete maximal auftretende Druck innerhalb des Gehäuses gemessen. Die Prüfung gilt als bestanden, wenn keine bleibenden Verformungen auftreten, welche die Zündschutzart aufhebt. Vorversuche bestätigen, dass der Druck als alleinige Messgröße, kein Indikator für eine dauerhafte Verformung ist. Es stellt sich die Frage, wie das Materialverhalten bei unterschiedlichen Spannungszuständen quantifiziert werden kann und welche Parameter dabei eine Rolle spielen. Die Antwort darauf ist für Hersteller von druckfesten Gehäusen relevant, da dadurch eine effektivere Konstruktion möglich ist. In diesem Beitrag werden statische und dynamische Untersuchungen vorgestellt, bei denen Druck und Dehnung gemessen wurden. Zwischen den Versuchsreihen wurden Parameter, wie z.B. die Materialstärke, variiert und basierend auf diesen Daten eine Übersicht erstellt, um die Einflussparameter auf die Materialbeanspruchung zu identifizieren und zu quantifizieren. Erste Ergebnisse werden in dieser Arbeit dargestellt und diskutiert.

K 1.3 Mon 15:00 f428

Synchronous VUV light source for FLASH II — •Elisa Appi[1,2], Christina Papadopoulou[3], Hannes Lindenblatt[4], Florian Trost[4], Tino Lang[3], Christoph Heyl[3], Bastian Manschwetus[3], Ingmar Hartl[3], Robert Moshammer[4], Uwe Morgner[1,2], and Milutin Kovacev[1,2] — [1]Institut für Quantenoptik, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover — [2]Cluster of Excellence PhoenixD (Photonics, Optics, and Engineering -Innovation AcrossDisciplines), Hannover, Germany — [3]DESY, Notkestrasse 85, 22607 Hamburg — [4]Max Planck Institute of Nuclear Physics, 69117 Heidelberg

We present a new setup for two-color VUV-XUV pump-probe experiments integrated in the FL26 [1] beamline of FLASH II (DESY). A high order harmonic source, driven by OPCPA laser pulses (700-900nm, <20fs), provides photon energies between 10 and 40 eV, which are optically synchronized with the FEL burst mode. The VUV radiation is coupled in the FEL beamline with a hyperbolic mirror and focused in the reaction microscope [2] (REMI) end-station. Spatial and temporal overlap between the VUV and the FEL beam can be achieved thanks to a split-and-delay unit, already present in the beamline. First tests on the harmonic generation and the coupling in REMI were successfully accomplished.

[1] G. Schmid *et al.*, Synchrotron Radiat. **26**, 854-867 (2019)

[2] R. Moshammer *et al.*, Nucl. Instruments Methods Phys. Res. Sect. B: Beam Interactions with Mater. Atoms **108**, 425-445 (1996)

K 1.4 Mon 15:15 f428

Dynamically assisted nuclear fusion — •Ralf Schützhold[1,2,3] and Friedemann Queisser[1,2,3] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstraße 400, 01328 Dresden, Germany — [2]Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden, Germany — [3]Fakultät für Physik, Universität Duisburg-Essen, Lotharstraße 1, Duisburg 47057, Germany

We consider deuterium-tritium fusion as a generic example for general fusion reactions. For initial kinetic energies in the keV regime, the reaction rate is exponentially suppressed due to the Coulomb barrier between the nuclei, which is overcome by tunneling. Here, we study whether the tunneling probability could be enhanced by an additional electromagnetic field, such as an x-ray free electron laser (XFEL). We find that the XFEL frequencies and field strengths required for this dynamical assistance mechanism should come within reach of present-day or near-future technology.

Phys. Rev. C 100, 041601(R) 2019

K 1.5 Mon 15:30 f428

Pump-Probe High-Resolution X-Ray Holography of Cavitation Dynamics at the European XFEL — •Malte Vassholz[1], Hannes P. Hoeppe[1], Juan M. Rosselló[2], Robert Mettin[2], Johannes Hagemann[3], Markus Osterhoff[1], Andreas Schropp[3], Christian G. Schroer[3], Johannes Möller[4], Anders Madsen[4], and Tim Salditt[1] — [1]Institut für Röntgenphysik, Universität Göttingen, Germany — [2]3. Phys. Institut, Universität Göttingen, Germany — [3]Deutsches Elektronen-Synchrotron, Hamburg, Germany — [4]European XFEL GmbH, Schenefeld, Germany

Cavitation phenomena play an important role in technology, sonochemistry and medicine. X-ray holography at free electron lasers provides a unique tool to study cavitation dynamics with 10-100fs resolution in time and below optical resolution in space. In addition, with X-rays it is possible to observe the density distribution inside the cavitation bubble, which is inaccessible for observation with optical light. Hence, X-rays can make the dynamics of the process of nucleation and formation of cavitation bubbles visible, helping to understand and model cavitation dynamics. We performed an X-ray holography experiment at the MID beamline of the European XFEL. An infrared ns laser pump drove the cavitation process, whereas the X-ray laser probed the dynamics. By forward modeling and iterative phase retrieval, the X-ray holograms yield the density and pressure distributions of the cavitation bubbles in space and time. The experiment provides an insight in the dynamics of single individual cavitation bubbles up to statistics of more than 10000 individually probed events.

K 1.6 Mon 15:45 f428

Design of a Laser Compton Backscattering Source for Beam Diagnostics at the S-DALINAC — •Maximilian Meier[1], Michaela Arnold[1], Vincent Bagnoud[2], Joachim Enders[1], Norbert Pietralla[1], and Markus Roth[1] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]GSI Helmholzzentrum für Schwerionenforschung, Darmstadt, Germany

Laser Compton Backscattering (LCB)[1] provides quasi-monochromatic highly polarized beams on the X-ray and gamma-ray regime for a variety of applications. A powerful stable and well synchronized laser with a high repetition rate is essential for a high-flux Compton light source with narrow energy bandwidth. A project at TU Darmstadt foresees to synchronize a high-repetition high-power laser with electrons from theS-DALINAC [2] to realize a LCB photon beam with energy up to 180 keV. The main goal in the first years will be to use LCB as an additional diagnostic tool for determining the electron beam energy and the energy spread of the S-DALINAC, with respect to the energy-recovery linac (ERL [3]) operation as well as the optimizing design considerations for a Compton light source. An overview over the required laser system for LCB at the S-DALINAC will be given, and simulations on the layout and the estimated output will be presented. [1] C. Bemporad et al., Phys. Rev. 138, B1546 (1965) [2] N. Pietralla, Nucl. Phys. News 28(2), 4 (2018) [3] M. Arnold et al., Proc. IPAC'18, 4859(2018) Supported through the state of Hesse (LOEWE research cluster Nuclear Photonics) and DFG through GRK 2128 "AccelencE".

K 2: Laser Systems

Time: Tuesday 14:00–15:45 Location: f428

K 2.1 Tue 14:00 f428

Femtosecond 100 W-level OPCPAs from 800 nm to 2 μm — Robert Riedel[1], Michael Schulz[1], Ivanka Grguraš[1], Torsten Golz[1], Jan H. Buss[1], and •Mark J. Prandolini[1,2] — [1]Class 5 Photonics GmbH, Notkestr. 85, 22607 Hamburg, Germany — [2]Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

High power and high repetition rate lasers are critical for many applications in the physical, chemical, and biological sciences. Previously, laser sources from x-ray to THz were driven from Ti:Sapphire lasers at 800 nm with limited bandwidth (Fourier limited pulse of 20 fs), and more importantly limited power levels; power levels 40 W and above require large complex cooling systems. Optical parametric chirped-pulse amplification (OPCPA) together with bulk crystal white-light-generation (WLG) opens up the possibility of high power lasers (well above 100 W), with wavelength tunable and broadband (for example, $<$ 10 fs at 800 nm), requiring no complex cooling with a compact design. Recently, 100 W-level OPCPAs are now commercially available from Class 5 Photonics GmbH from 800 nm to 2 μm.

K 2.2 Tue 14:15 f428

A thin-disk pumped OPCPA system delivering >4 TW pulses — •Martin Kretschmar[1], Johannes Tümmler[1], Bernd Schütte[1], Andreas Hoffmann[1], Björn Senfftleben[1], Mark Merö[1], Mario Sauppe[1,2], Daniels Rupp[1,2], Marc Vrakking[1], Ingo Will[1], and Tamas Nagy[1] — [1]Max-Born-Institut, Max-Born-Straße 2A ,Berlin — [2]ETH Zürich, John-von-Neumann-Weg 9, Zürich

Nonlinear optical interactions can already be studied in the XUV spectral window, where free electron lasers serve as a reliable source for intense XUV pulses. On a laboratory scale, the generation of intense XUV pulses is realized through high harmonic generation (HHG), calling for driving lasers delivering pulses in the Terawatt (TW) regime.

Here, we present an optical parametric chirped pulse amplification (OPCPA) system delivering >40 mJ near infrared pulses with a pulse duration below 8 fs, which corresponds to a peak power well exceeding 4 TW. The parametric amplification process is pumped by two home-built thin-disk lasers operating at 100 Hz with a pump pulse duration below 10 ps. The TW pulses are applied for HHG, enabling the generation of near μJ level XUV pulses, which can drive nonlinear strong field processes [1] and are a potential source for attosecond pump-probe experiments.

[1] Senfftleben et al., arXiv:1911.01375

K 2.3 Tue 14:30 f428

Influence of the dispersion in a doubly resonant optical parametric oscillator — •Christian Markus Dietrich[1,2], Ihar Babushkin[1,2,3], José R.C. Andrade[1,2], Han Rao[1,2], and Uwe Morgner[1,2] — [1]Leibniz University Hannover, Institute for Quantum Optics, Hannover, Germany — [2]Cluster of Excellence PhoenixD, Hannover, Germany — [3]Max Born Institute, Berlin, Germany

We present measurements and a numerical model of the spectral behaviour of a doubly resonant optical parametric oscillator (DROPO) in relation to the intracavity second and third order dispersion. DROPOs can be interesting light sources for comb generation and spectroscopy. In a DROPO the signal and idler wavelengths are both resonant and need to fulfill a proper phase relation, which is influenced by the dispersion of the cavity. This leads to complex length detuning characteristics in the optical spectrum. Self phase locking of the DROPO to the pump appears at degeneracy and proper length tuning. By using this effect, phase-stable multi-color light fields can be generated which are promising for high harmonic generation and other effects. Our experimental work is explained by a numerical model solving the coupled differential equations for the two orthogonal polarization directions in the amplifier crystal. Even though the model is restricted to one spatial dimension only, it can help for understanding the complex pulsing dynamics in a DROPO.

K 2.4 Tue 14:45 f428

Pump Combiner with Chirally Coupled Core Fibers for Single Frequency All Fiber Amplifier — •Eike Brockmüller[1,2], Sven Hochheim[1], Peter Wessels[1], Joona Koponen[3], Tyson Lowder[4], Steffen Novotny[3], Jörg Neumann[1], and Dietmar Kracht[1] — [1]Laser Zentrum Hannover e.V., Laser Development Department, Hollerithallee 8, 30419 Hannover, Germany — [2]Universität zu Lübeck, Ratzeburger Allee 160, 23562 Lübeck, Germany — [3]nLight Oy, Sorronrinne 9, 08500 Lohja, Finland — [4]nLIGHT Inc., 5408 NE 88th Street, Vancouver, WA 98665, USA

To increase its sensitivity, the next generation of gravitational wave detectors requires single frequency lasers in a linearly polarized TEM_{00}-mode with high output power. It was shown that fiber based amplifier systems can meet these requirements with low complexity. However, they are limited by the nonlinear effect of stimulated Brillouin scattering (SBS). The concept of a chirally coupled core (3C®) fiber allows single-mode operation with a large mode area core and therefore raises the limit for the onset of SBS. A key element of such an amplifier setup is the pump combiner. We present the development of a pump combiner using a side-pumping technology in which the pump light is coupled into an active 3C® fiber with the key advantage of an uninterrupted signal core and without the need of an additional fusion splice in the amplifier setup. This should lower the complexity, reduce power losses and increase the robustness of the amplifier system, which further emphasizes the high potential of fiber amplifiers as laser sources for the next generation of gravitational wave detectors.

K 2.5 Tue 15:00 f428

15 W Er^{3+}:Yb^{3+}-codoped fiber laser for in-band Er^{3+} pumping — •Marian Dürbeck, Phillip Booker, Omar de Varona, Michael Steinke, Peter Wessels, Jörg Neumann, and Dietmar Kracht — Laser Zentrum Hannover e.V., Hollerithallee 8, D-30419 Hannover, Germany

Single-frequency Er^{3+}:Yb^{3+}-codoped fiber amplifiers in MOPA configuration are promising candidates to fulfil the challenging requirements of 1.5 μm laser sources for the third generation of interferometric gravitational wave detectors (GWDs). However, typical high-power pump sources only come with high NA and thus require long double-clad fiber lengths favourable for non-linearities such as SBS. On the other hand, single-mode core-pumping sources only come in the form of a cascaded Raman laser with high complexity designs. In this work, we demonstrate a low-complexity and single-mode Er^{3+}:Yb^{3+}-codoped fiber laser centered around 1530 nm and off-peak pumped at 915 nm, as a pump source for core-pumped amplifiers. We optimized the laser resonator by testing different commercially available SM-Er^{3+}:Yb^{3+} fibers and their respective lengths with different outcoupler reflectivites. We characterized the laser for up to 15.5 W of output power (stability, noise-performance, spectrum and beam profile) with a slope-efficiency of 42.2 % and confirmed the absence of detrimental Yb^{3+}-ASE by optical spectrum measurements.

K 2.6 Tue 15:15 f428

Attosecond streaking of an infrared parametric waveform synthesizer — •Fabian Scheiba[1], Giulio Maria Rossi[1], Roland E. Mainz[1], Yudong Yang[1,2], Miguel A. Silva-Toledo[1], Phillip D. Keathley Keathley[3], Giovanni Cirmi[1,2], and Franz X. Kärtner[1,2] — [1]Center for Free-Electron Laser Science CFEL and Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany and Physics Department, University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]The Hamburg Centre for Ultrafast Imaging, Luruper Chaussee 149, 22761 Hamburg, Germany — [3]Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA

Synthesis of optical fields based on optical parametric amplifiers

(OPAs) is a promising approach for energy- and wavelength-scalable sources. Here, a NIR ((0.65-0.95) μm) and IR ((1.2-2.2) μm) spectral channel with a relative phase stability of 70 mrad are synthesized to a >1.5 octave spanning pulse with a measured CE-phase stability of 233 mrad, a central wavelength of 1.4 μm and a FWHM duration down to 2.8 fs. The full spatio-temporal stabilization allows for the generation of continuous XUV spectra via high harmonic generation (HHG) in gases with an energy stability of 5.9% rms. Attosecond streaking experiments visualize the measured electric field waveforms generated and prove the excellent long-term pulse-to-pulse stability as well as versatility in shaping the synthesized waveforms to non-sinusoidal fields in the sub-cycle limit.

K 2.7 Tue 15:30 f428

High-harmonic generation control with intense, infrared, synthesized waveforms — •Miguel A. Silva-Toledo[1], Roland E. Mainz[1], Yudong Yang[1,2], Giulio Maria Rossi[1], Fabian Scheiba[1], Guangjin Ma[1], Phillip D. Keathley[3], Giovanni Cirmi[1,2], and Franz X. Kärtner[1,2] — [1]Center for Free-Electron Laser Science (CFEL) and Deutsches Elektronen-Synchrotron (DESY), Notkestraße 85, 22607, Hamburg, Germany — [2]The Hamburg Centre for Ultrafast Imaging, Luruper Chaussee 149, 22761 Hamburg, Germany — [3]Research Laboratory of Electronics, Massachussets Institute of Technology, Cambridge, Massachussets 02139, USA

Sub-cycle shaping of light fields driving high-harmonic generation (HHG) allows full amplitude- and phase-control of coherent extreme ultraviolet (XUV) to soft X-ray radiation. Here, we show such control in the XUV regime via tailored driver pulses, delivered by an optical parametric amplification-based waveform synthesizer. Synthesis is achieved by combining near-infrared (NIR) (0.65 - 1.0 μm, $\sim$ 6 fs, $\sim$ 150 μJ) and infrared (IR) (1.2 - 2.2 μm, $\sim$ 8 fs, $\sim$ 500 μJ) pulses. Upon variation of the CEP and relative phase between NIR and IR pulses, we modulate the spectrum and yield of attosecond pulse trains and of isolated attosecond pulses (IAPs). Attosecond streaking measurements characterize the driver pulses and IAPs. Experimental observations are also combined with macroscopic HHG simulations. Our study will facilitate research on optimal driver fields for efficient soft X-ray HHG.

K 3: Annual General Meeting

Time: Tuesday 15:45–16:00 Location: f428

Duration: 15 min.

K 4: Poster

Time: Tuesday 16:30–18:30 Location: f428

K 4.1 Tue 16:30 f428

High-power OPCPAs at 1.45 - 2.4 μm wavelength — Ivanka Grguras[1], Jan-Heye Buss[1], Torsten Golz[1], Mark Prandolini[1,2], Michael Schulz[1], and •Robert Riedel[1] — [1]Class 5 Photonics GmbH, Notkestrasse 85, 22607 Hamburg, Germany — [2]Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

High power and high repetition rate femtosecond lasers at 1.45 - 2.40 μm wavelength are critical for many applications in the physical, chemical, and biological sciences. Previously, such systems have been realized by optical parametric amplification from Ti:Sapphire lasers at 800 nm with limited power levels. A novel optical parametric chirped-pulse amplifier (OPCPA), pumped by high-power Yb-doped solid state lasers, and combined with bulk crystal white-light-generation seeding (WLG) is demonstrated. The laser system features tunable and broadband operation in the 1.45 - 2.40 μm spectral range, requiring no complex cooling with a compact footprint. Such systems have recently become commercially available from Class 5 Photonics and allow for scalability up to millijoule pulse energies at 100 W average power with a tunable range from 1.45 - 2.45 μm.

K 4.2 Tue 16:30 f428

An XUV and soft x-ray split-and-delay unit for FLASH2 — •Matthias Dreimann[1], Sebastian Roling[1], Ivan Zadyraka[3], Marion Kuhlmann[2], Elke Plönjes-Palm[2], Frank Wahlert[3], Felix Rosenthal[1], Michael Wöstmann[1], and Helmut Zacharias[1] — [1]Center for Soft Nanoscience, Münster, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [3]Westfälische Wilhelms-Universität, Münster, Germany

An XUV and soft x-ray split-and-delay unit is built that enables time-resolved pump-probe experiments covering the whole spectral range of FLASH2 from hv = 30 eV up to 1500 eV. With wavefront beam splitting and grazing incidence angles sub-fs resolution with a maximum delay of -6 ps $< t <$ +18 ps will be achieved. Two different coatings are required to cover the complete spectral range. Therefore, a design that is based on a three dimensional beam path allows to choose the propagation via two sets of mirrors with these coatings. A Ni coating will allow a total transmission on the order of T = 55 % for photon energies between hv = 30 eV and 600 eV at a grazing angle of w = 1.8° in the variable delay line. With a Pt coating a transmission of T > 13 % will be possible for photon energies up to hv = 1500 eV. In the fixed beam path at a grazing angle of w = 1.3° a transmission of T > 62 % with a Ni coating and T > 28 % with a Pt coating will be possible. For a future upgrade of FLASH2 the Ni coating can be used at a grazing angle of w = 1.3° to cover a range up to hv = 2500 eV.

K 4.3 Tue 16:30 f428

The HeH^+ ion in intense asymmetric field — •Saurabh Mhatre and Stefanie Gräfe — Institut für Physikalische Chemie, Friedrich-Schiller-Universität Jena, Helmholtzweg 4, 07743 Jena, Deutschland

We investigate the dynamics of dissociation and ionization of highly asymmetric HeH^+ ion. The large mass and electronic asymmetry in the HeH^+ ion makes it an ideal candidate for the dynamics in few-cycle intense laser pulses. We employ our recently developed semi-classical dressed surface hopping model to simulate all possible fragmentation pathways such as dissociation, single and double ionization. These pathways can be accessed in multiphoton as well as tunnelling regime. By using specifically tailored femtosecond pulses, we aim to control these fragmentation pathways.

K 4.4 Tue 16:30 f428

AOM shaper-based D-Scan in the mid-infrared region — •Florian Nicolai, Niklas Müller, and Tiago Buckup — Physikalisch-Chemisches Institut, Universität Heidelberg, 69120 Heidelberg, Germany

Pulse duration and phase characterization play a central role in ultrafast time-resolved spectroscopy. One method to determine the pulse's spectral amplitude and phase is dispersion scan (d-scan). In this technique, a known amount of dispersion is added to the pulse and its effect on the second harmonic spectrum is observed. The d-scan method has already shown its success in the visible and near infrared spectral region. However, implementing a d-scan setup for mid infrared (MIR) pulses is quite challenging, especially due to the lack of suitable materials to imprint the desired amount of dispersion on the pulse. We show the successful realization of a d-scan setup for pulses in the MIR region at about 5.0 μm with an acousto-optic modulator (AOM). In this way we implemented a compact setup to determine the spectral phase of a MIR pulse. Furthermore, the AOM shaper has the potential to add an arbitrary phase and thus to compress the pulse.

K 4.5 Tue 16:30 f428

Terahertz radiation in tailored two-color laser fields with nanostructure semiconductor — •Han Rao[1,2], Ihar Babushkin[1,2], Christian Markus Dietrich[1,2], Jose Ricardo Cardoso de Andrade[1,2], and Uwe Morgner[1,2] — [1]Leibniz University Hannover, Institute for Quantum Optics, Hannover, Germany — [2]Cluster of Excellence PhoenixD, Hannover, Germany

Terahertz (THz) technology has attracted much attention due to its potential in various applications such as: remote sensing, biology and medicine, security scanning, information and wireless communication technology. THz sources based on two-color ionizing femtosecond (fs) pulses in gases stand out because of absence of damage threshold, absence of phonon absorption and zero interface reflection. Such approach, based on ionization, was up to now not realized in solids. In our case, we use the semiconductor nanodots for THz generation which can be fabricated with tunable band gap. Here, we present a concept of THz pulse generation in semiconductor nanodots with two color pulses, which, as we believe, can generate THz radiation with much higher efficiency than in gases. The two-color driver will be delivered with 40 MHz a doubly resonant optical parametric oscillator (DROPO) which can generate 2060 nm light in the fs region. The DROPO pump source is a home-built Kerr-lens mode-locked Yb:YAG thin disk laser, emitting pulses at a wavelength of 1030 nm with a pulse duration of 250 fs, and 40 W output power and 40 MHz repetition rate.

K 4.6 Tue 16:30 f428

High-Order Harmonic Generation in Liquids — •Jan Heine, Christoph Jusko, Elisa Appi, Uwe Morgner, and Milutin Kovacev — Institut für Quantenoptik, Cluster of Excellence PhoenixD, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover

High-order Harmonic generation (HHG) is a well established technology for probing ultrafast processes, allowing researchers to generate ultra-short optical pulses in the attosecond regime through nonlinear frequency conversion. While the generation process in gas-phase targets is well understood, there is still ongoing investigation on the interaction of ultrashort laser pulses with high-density media such as liquids [1] and solids [2]. Here, we present a HHG source using liquid droplets, with which we can investigate the impact of different target geometries (e. g. water sheet/droplet) and possible additives on the generation process. We are currently working on reducing the target size to be comparable to the wavelength of our driving pulse. This way we expect to see interesting dynamics, similar to the interaction of laser pulses with solid nanostructures and nanoantennas.

[1] T. T. Luu *et al.*, Nature Commun. 9, 3723 (2018)
[2] S. Ghimire *et al.*, Nature Phys. 15, 10-16 (2019)

K 4.7 Tue 16:30 f428

Detection and safety precautions of generated X-ray during laser material processing — •Zulqarnain Sheikh[1,2], Uwe Morgner[1,2], and Milutin Kovacev[1,2] — [1]Institut für Quantenoptik, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover — [2]Cluster of Excellence PhoenixD (Photonics, Optics, and Engineering - Innovation AcrossDisciplines), Hannover, Germany

The global market for laser material processing systems is rapidly increasing over the past few years[1]. From laser cutting to laser drilling and laser marking, high power ultrashort pulse lasers are versatile tool for production. Plasma generation during laser processing with ultrashort laser pulses puts the risk of unwanted X-ray radiation in the range of several kilo electron volts. We performed experiments to detect the generated X-rays(soft and hard X-rays between 200eV to 10,000eV) using X-ray camera while processing different solid materials and investigate the exposure safety limits[1,2].

[1] Legall *et al.*, (2018) Applied Physics A, 124(6), 407.
[2] De Bruijn *et al.*, U.S. Patent No. 7,755,070. 13 Jul. 2010.

K 4.8 Tue 16:30 f428

A semiclassical Two Temperature-Hydrodynamic Model for surface plasmons-polaritons assisted nanostructuring of metals using ultrafast laser pulses — •Othmane Benhayoun — Department of Theoretical Physics II, University of Kassel

We propose a semiclassical Two Temperature-Hydrodynamic Model (TTH) based on field equations to investigate the role of electrons and surface plasmons-polaritons on the energy exchange with the lattice, which can lead to the creation of laser induced periodic surface structures (LIPSS) in metals subject to ultrashort laser pulse excitation. The TTH equations are constructed by applying perturbation theory on the energy-, momentum- and density conservation equations of the electronic system. We consider three subsystems: the lattice, the thermalized electrons and the surface plasmons, all of which are coupled to each other by collision terms, and coupled to an external laser field. A numerical analysis is then performed on gold, where we compare our results with the classical TTM for different laser fluences, and show the emergence of an oscillation pattern in the electronic and lattice temperature distribution, in both single and multi-pulse regimes, which can be responsible for the formation of ripples on the surface of the material.

K 4.9 Tue 16:30 f428

Correlation between lasers induced carbonization and LIBS on leather — •Dominic Bergmeister[1], Alexander Feist[2], Ali Hachimi[2], Mareike Schäfer[2], Johannes L'huillier[2], and Peter Schultheis[1] — [1]Prüf- und Forschungsinstitut Pirmasens e.V., 66953 Pirmasens, Germany — [2]Photonik-Zentrum Kaiserslautern e.V. and Research Center OPTIMAS, 67633 Kaiserslautern, Germany

The industry 4.0 sets the shoe industry for great challenges, automation is due to the large use of leather very problematic. To bond leather to the sole, it is necessary to remove the finish from leather. In shoe industry this roughening process is still often done by hand. Investigations showed the potential of ultra-short pulse lasers for the roughening process. However, it is required to adapt the laser parameters to the respective leather type in order to avoid carbonization on the surface, which reduce the adhesive strength. Our approach is to regulate the laser output power, which is critical for the carbonization, through laser induced breakdown spectroscopy (LIBS). Due to the thermal process of the carbonization during laser processing of leather, it is possible to detect the broad emission spectrum by LIBS. To establish a control, it is necessary to correlate the spectra with the carbonization. For this, the carbonization is also quantified with a sample speckled on the processed leather area and analyzed of residue on the surface. The results show the correlation between the spectrum, the speckle tests and the adhesive tests on leather according to DIN 1392. Based on these results we are able to establish an automatic control for the laser processing of leather samples.

K 4.10 Tue 16:30 f428

LIPSS guided by photolithographic pre-structured polymer films — •Martin Ehrhardt[1], Shengying Lai[1,2], Pierre Lorenz[1], and Klaus Zimmer[1] — [1]Leibniz Institute of Surface Engineering (IOM), Permoserstr. 15, 04318 Leipzig, Germany — [2]School of Science, Nanjing University of Science & Technology, Xiaolingwei 200, Nanjing 210094, China

The formation of LIPSS (Laser induced periodic surface structures) was discussed and investigated in detail in the last decades. However, only few studies were published dealing with the guiding of LIPSS on pre-structured substrates. In the present study, LIPSS formation on polymer dot and line structures is presented. The LIPSS are induced by a partial polarized excimer laser radiation (t=25ns, λ=248nm). The degree of order of the LIPSS are influenced by the shape and geometry of the polymer pre-structures as well as the alignment of the laser polarization to the pre-structure direction. Several hundred micrometers long LIPSS were observed using an optimized adjustment of the alignment as well as an adapted laser parameter set (fluence and laser pulse number). The highly ordered LIPSS formation process can accept alignment mismatches up to 10 °. The LIPSS are induced at the top and the side wall of the pre-structured polymer dependent on the applied laser parameters, respectively.

K 4.11 Tue 16:30 f428

Time Resolved X-ray Holography of Cavitation Dynamics at European XFEL — •Hannes P. Hoeppe[1], Malte Vassholz[1], Juan M. Rosselló[2], Robert Mettin[2], Johannes Hagemann[3], Markus Osterhoff[1], Andreas Schropp[3], Christian G. Schroer[3], Johannes Möller[4], Anders Madsen[4], and Tim Salditt[1] — [1]Institut für Röntgenphysik, Universität Göttingen, Germany — [2]3. Phys. Institut, Universität Göttingen, Germany — [3]Deutsches Elektronen-Synchrotron, Hamburg, Germany — [4]European XFEL GmbH, Schenefeld, Germany

High-resolution X-ray Holography with Free Electron Laser radiation enables imaging of fast and ultrafast processes, based on illumination with single X-ray pulses with durations less than 100 fs. We present an investigation of laser-induced Cavitation dynamics in water by X-ray Holography in an optical pump- x-ray probe experimental scheme. Two experiments have been performed in June and October 2019 at the MID Instrument of European XFEL. Cavitation dynamics was studied in three geometries: undisturbed seeding in a flow-through chamber, surface-near seeding and cavitation in a free water jet. We have in particular imaged the fast transition from plasma to vapour, leading to shock wave emission and bubble formation. By iterative phase retrieval or forward modeling, the radial density profiles of early state plasma distribution and cavitation bubbles are obtained. In unique ways, this gives insight to the phase transition and energy balance of the seeding process, as well as volumetric information about the shape and density distribution of later states of the cavitation bubbles.

K 4.12 Tue 16:30 f428

Femtosecond noncollinear optical parametric oscillator in the visible spectral range — •Robin Mevert[1], Christian Markus Dietrich[1,2], José R.C. Andrade[1,2], Luise Beichert[1,2], and Uwe Morgner[1,2] — [1]Leibniz University Hannover, Institute for Quantum Optics, Hannover, Germany — [2]Cluster of Excellence PhoenixD, Hannover, Germany

We present a widely-tunable non-collinear optical parametric oscillator (NOPO) in the visible spectral range. NOPOs are very interesting for spectroscopic applications due to their ability to create frequency tunable ultrashort laser pulses at wavelengths unreachable for most available lasers. This is especially important for the visible spectral range. By changing the resonator length the center wavelength of the signal can be tuned from 430 nm to 690 nm. The NOPO is pumped by the third harmonic (343 nm) of a two-stage fiber amplifier seeded by a nonlinear polarization rotating fiber oscillator at 1030 nm and a repitition rate of 50.2 MHz. An average power of 3W UV-pump-light is used to create average output powers up to 485 mW at 605 nm.

K 4.13 Tue 16:30 f428

Quantitative coherent diffraction imaging via deep learning: from simulation to reconstruction — •Alessandro Colombo[1], Julian Zimmermann[2], and Daniela Rupp[1] — [1]ETH Zürich, 8093 Zürich, Switzerland — [2]Max-Born-Institut, 12489 Berlin, Germany

Coherent Diffraction Imaging (CDI) is a lens-less technique that exploits the 2D measured diffraction pattern $I(\vec{k})$, produced by short-wavelength coherent radiation illuminating e.g. an individual nanoscale structure, to retrieve its electron density distribution $\rho(\vec{x})$. The use of Deep Learning for classifying diffraction patterns already proved to outperform standard approaches [1]. Here we present an approach based on Deep Convolutional Neural Networks for regression, to directly retrieve the electron density structure $\rho(\vec{x})$ when classical reconstruction algorithms do not apply, as, for example, in the wide-angle scattering regime. The generation of a sufficently large training dataset for the supervised learning of the network is done by simulating diffraction data. A model representation of the particle shapes, that enables parametrization, has to be found, with the goal of retrieving the optimized parameters from the neural network for each CDI pattern. The simulation software and the neural network are described, along with a first comparison with experimental data, showing that such a simulation-reconstruction scheme may provide a quick and quantitative insight into large CDI datasets.

[1] Zimmermann et al. *Physical Review E* 99.6 (2019): 063309.

K 5: Laser Systems and Laser Applications

Time: Wednesday 11:00–12:45 Location: f428

K 5.1 Wed 11:00 f428

Generation of Amplified Fourth Harmonic Picosecond Laser Pulses for Cooling of Relativistic Ion Beams at GSI and FAIR — •Thomas Werner[1], Sebastian Hepp[1], Daniel Kiefer[1], Sebastian Klammes[1,2], and Thomas Walther[1] — [1]TU-Darmstadt, Institut für Angewandte Physik, Laser und Quantenoptik, Schlossgartenstr. 7, 64289, Darmstadt — [2]GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt

White-light cooling of relativistic ion beams promises to be an efficient and effective means to obtain low momentum spreads [1] with minimized intrabeam scattering (IBS) processes [2]. A cw ECDL laser system in combination with acousto-optical and electro-optical modulation provides short pulse lenghts of 50ps to 740ps [3] in order to generate the required spectral width. The doppler shifted transition wavelength of 275.5nm of relativistic ions is generated in two consecutive SHG processes that require high peak intensities. Therefore, the modulated laser pulses are amplified in a series of three*Ytterbium-doped*fiber amplifiers. We will present the current status of the experiment and future developments. [1] U. Schramm et al, Proceedings of (2005) Particle Accelerator Conference, [2] R. Calabrese, Hyperfine Interactions 99, 259-265,(1996), [3] D. Kiefer and T. Walther, "Picosecond Ultraviolet Pulses at 257 nm with Variable Transform Limited Linewidth and Flexible Repetition Rate," in Laser Congress 2018 (ASSL), OSA Technical Digest (Optical Society of America, 2018), paper AW1A.2.

K 5.2 Wed 11:15 f428

Femtosecond laser generated Mach-Zehnder interferometers based on integrated optical waveguides — •Boldizsar Kassai[1,2], Sabine Tiedeken[1], Volker Braun[1], Braun Teubner[1,2], and Hans Brückner[1] — [1]Institut für Laser und Optik, Hochschule Emden/Leer - University of Applied Sciences, Constantiaplatz 4, D-26723 Emden — [2]Institut für Physik, Carl von Ossietzky Universität Oldenburg, D-26111 Oldenburg

Direct writing of optical waveguides in glass by laser exposure deals with at least two unknown parameters: The amount of index modification and the geometry of the waveguide. To solve these problems for guiding structures in Herasil glass, Mach-Zehnder interferometers (MZI) and straight waveguides were generated by direct femtosecond laser radiation (pulse duration 275fs, pulse energy 600nJ, repetition rate 1kHz). All structures are buried 0.1mm deep below the surface. The straight optical waveguides exhibit single mode guiding behavior at 650 nm with nearly circular mode fields and diameters between 5 and 8 microns. The interference signals of asymmetric MZI with short sections of unmodified glass in one path were evaluated at several wavelengths. Thus an effective index increase in the guides of about 0.01 due to laser irradiation was determined. Based on these values, the comparison of the measured mode fields with results from numerical simulations leads to the conclusion of a graded index profile with a maximum of 0.012 and a full 1/e-width of about 0.015 mm. The current results show that MZIs can be used to determine the influences of various laser exposure parameters on index modifications in glass.

K 5.3 Wed 11:30 f428

THz generation by optical rectification for a novel shot to shot synchronization system between electron bunches and femtosecond Laser pulses in a plasma wakefield accelerator — •Stefano Mattiello[1], Holger Schlarb[2], and Andreas Penirschke[1] — [1]Technische Hochschule Mittelhessen, Friedberg, Deutschland — [2]DESY, Hamburg, Deutschland

We investigate the influence of the optical properties and of the theoretical description of the THz generation on the conversion efficiency as well as on the optimum crystal length for the generation length of short THz pulses. The application is a feedback system for SINBAD with a time resolution of less than 1 fs for the synchronization of the electron bunch and of the plasma wake field in a laser driven plasma particle accelerator. Here stable THz pulses are generated by optical rectification of a fraction of the plasma generating high energy laser pulses in a nonlinear lithium niobate crystal. Then the generated THz pulses will energy modulate the electron bunches shot to shot before the plasma to achieve the required time resolution. In this contribution we compare different approximations for the modeling of the generation dynamics applying second order or first order equations, using different approximations for the optical properties as well as considering pump depletion effects. Additionally, a comparison with new analytic solutions for a dispersive medium is presented.

K 5.4 Wed 11:45 f428

Micro- and nanostructuring of metal surfaces by ultra-short laser pulses — •Pierre Lorenz[1], Marcel Himmerlich[2], Martin Ehrhardt[1], Karolina Bogdanowicz[2], Mauro Taborelli[2], Bela Hopp[3], Bing Han[4], and Klaus Zimmer[1] — [1]Leibniz Institute of Surface Engineering (IOM), Leipzig, Germany — [2]CERN - European Organization for Nuclear Research, Switzerland — [3]University of Szeged, Szeged, Hungary — [4]Nanjing University of Science and Technology, Nanjing, China

The ultra-short laser irradiation of metal surfaces e.g. copper, nickel, chromium allows the direct adjustment of the surface topography in the micrometer range as well as the sub-μm periodic structuring due to the LIPSS (laser-induced periodic surface structures) formation process. Furthermore, laser treatment with high laser fluences allows the nanostructuring of the metal surface where the shape and chemical composition of the formed structures depends on the laser parameter as well as on the environment conditions (gas pressure and composition). The morphology and composition of the modified surface are analyzed by scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS). The laser treatment is performed on plane and curved surfaces up to several 100 cm^2. Furthermore, the different applications of the fabricated structures will be presented.

K 5.5 Wed 12:00 f428

Magnetic field-assisted laser ablation of silicon — Falicienne G. Keabou[1], Garik Torosyan[1], •Yiyun Kang[1], Hicham Derouach[1], Xavi del Arco[2], Pavel Terekhin[2], Mareike Schäfer[1], Bärbel Rethfeld[2], and Johannes A. L'huillier[1] — [1]Photonik-Zentrum Kaiserslautern e.V., 67633 Kaiserslautern, Germany and Research Center OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Department of Physics and Research Center OPTIMAS, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany

Laser micromachining is an enabling technology for numerous applications. A well-controlled ablation process is often crucial for a certain application. Only the temporal and spatial pulse separation as well as the pulse energy and pulse duration are in the sphere of influence of the experimentalists. After applying the ultra-short laser pulse to the surface virtually no control is possible. A new, highly promising approach to achieve a deeper control is to apply an external magnetic field parallel to the laser beam axis during laser ablation. The magnetic field allows for a stronger absorption of the pulses in the excited area of the medium, shall provide a local confinement for the hot electrons and may influence the plasma. In this study, a static magnetic field up to 233 mT is applied during multi-pulse ablation and by processing cavities on silicon for short as well as ultrashort laser pulses. An enhancement of ablation depth and a clean processed and well defined shape is achieved. A first theoretical model analyzing the energy distribution of heated electrons is developed.

K 5.6 Wed 12:15 f428

Molecular formation in femtosecond-laser-induced microplasmas and their applications — •Anne-Sophie Rother, Peter Kohns, and Georg Ankerhold — Hochschule Koblenz, RheinAhrCampus Remagen, Remagen, Deutschland

Irradiating focused laser-pulses on surfaces can generate local microplasmas, in which molecules mostly dissociate into their atomic constituents. These excited atoms and partly ions emit characteristic lines during the plasma cooling phase. Laser-induced breakdown spectroscopy uses these emission spectra to locally analyze the elemental composition of the irradiated surface.

After a few microseconds, the decreasingly excited atoms can recombine and sometimes form new molecules from formerly not bonded constituents, like calcium halides and metal oxides. While some of these molecules improve the elemental analysis by radiating identifying band spectra, others bond without emitting any lines. As we will show, the latter occurs when focusing femtosecond laser pulses on zinc surfaces in ambient air. After the emission of atomic zinc lines, also observable when using nanosecond pulses, only for ultrashort laser pulses crystalline dendrites of zinc oxide are formed and perform scattered second harmonic generation. As we examined, these scattering frequency doublers can be used in an amended optical autocorrelation setup for measuring the duration of ultrashort pulses, which leads to the same results as the much more expensive beta barium borate.

K 5.7 Wed 12:30 f428

Complete spatio-temporal characterization of femtosecond filaments in gases — •Christoph Jusko[1], Lana Neoričić[2], Sara Mikaelsson[2], Chen Guo[2], Shiyang Zhong[2], Anne L'Huillier[2], Uwe Morgner[1], Arnaud Couairon[3], Milutin Kovačev[1], and Cord Arnold[2] — [1]Institut für Quantenoptik, Cluster of Excellence PhoenixD and QuantumFrontiers, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover — [2]Department of Physics, Lund University, Professorsgatan 1, 223 63 Lund, Sweden — [3]CPHT, Ecole Polytechnique, Institut Polytechnique de Paris, Route de Saclay, 91128 Palaiseau, France

The propagation of femtosecond laser pulses in gas filaments is dominated by a dynamic balance of self-focusing due to the Kerr effect and defocusing due to plasma generation. This interplay of effects causes highly nonlinear dynamics acting on the spatio-temporal properties of the pulse which cannot be investigated seperately without an information loss. So far, due to the lack of adequate diagnostic methods, characterization studies of femtosecond filaments have solely looked at either the spatial or temporal dynamics of the pulse. We present the first study of complete spatio-temporal dynamics of a femtosecond filament, realized by filament termination [1] at defined points along its length and accurate pulse characterization by spatio-temporal Fourier transform spectrometry [2], supported by d-scan measurements [3].

[1] D. Steingrube *et al.*, New J. Phys. **13**, 043022 (2011)
[2] M. Miranda *et al.*, Opt. Lett. **39**, 5142 (2014)
[3] M. Miranda *et al.*, Opt. Express **20**, 688 (2012)

K 6: Lunch talk: German Research Foundation (DFG) (joint session A/K/P/MO/MS/Q)

Time: Wednesday 13:10–13:55 Location: f303

Lunch Talk K 6.1 Wed 13:10 f303

Funding by the German Research Foundation (DFG) – a brief overview — •Andreas Deschner — Deutsche Forschungsgemeinschaft (DFG), Kennedyallee 40, 53175 Bonn, Germany

During the last 100 years, the German Research Foundation (DFG) and its predecessors have been funding research in Germany. Today, the DFG is the central third party funding organization for basic research in Germany. It offers a broad spectrum of funding opportunities from individual grants to larger coordinated programs.

This talk will give a brief outline of the financial framework, the decision-making processes and the funding portfolio of the DFG. I will mostly focus on the different programs that offer support to early career scientists, e.g. the new Walter Benjamin for postdoctoral positions and the Emmy Noether program for junior research groups.

K 7: Laser Beam Interaction and Laser Diagnostics

Time: Wednesday 14:00–15:00 Location: f428

K 7.1 Wed 14:00 f428

Broadband mid-infrared phase reconstruction in the focal plane of a microscope — •Niklas Müller, Florian Nicolai, and Tiago Buckup — Physikalisch-Chemisches Institut, Universität Heidelberg, Deutschland

The temporal shape of ultrashort laser pulses has high impact on nonlinear and time-resolved spectroscopy. However, its exact shape is often not known due to challenges in phase reconstruction in all spectral regions, especially far beyond the visible region. The successful phase reconstruction over 1000 cm^{-1} of a mid-infrared (MIR) laser pulse ranging from 1750 cm^{-1} up to 3200 cm^{-1} is presented. After reconstructing the complex near-infrared (NIR) electric field by a dispersion scan based on a spatial light modulator, the phase retrieval in the MIR is performed on the sum-frequency signals generated by the NIR-MIR interaction. Two different approaches are implemented: (i) In a time scan method, the NIR laser beam is delayed by inserting a specific amount of glass. Thus, the detected sum-frequency light depends on the temporal overlap of the NIR and MIR laser pulses and allows a phase reconstruction. (ii) In the second method, the dispersion of both laser pulses is scanned via glass insertion in the collinear MIR and NIR beam path and phase reconstruction is provided by the dispersion scan method. Although not restricted to it, the nonlinear feedback signals are generated inside the focal plane of a nonlinear microscope and the phase reconstruction provides knowledge about the temporal shape of the driving laser pulses in the point of interest.

K 7.2 Wed 14:15 f428

Self-Written Optical Waveguides (SWWs) in Photopolymer Material — •Monali Suar, Axel Guenther, and Bernhard Roth — Hannover Centre for Optical Technologies, Leibniz Universität Hannover, Nienburger Str. 17, 30167 Hanover, Germany

Self-written optical waveguides (SWWs) have received much attention in recent years as light guiding elements in integrated photonic circuits of telecommunication networks. They lend themselves for fast and easy implementation techniques in photopolymer materials and can be realized with very low cost. The physics behind writing these SWW interconnects is influenced by the combined effect of self-focusing and self-trapping of light. An induced change in refractive index is observed as the laser-light propagates through the photopolymer sample leading to the formation of the SWWs. A combined experimental and theoretical study on SWWs was performed and is reported here. The multiphysics modeling and simulation part involved the implementation of a two-dimensional (2D) Crank-Nicholson based beam propagation method which was then coupled to a diffusion material model to obtain the induced change in refractive index. A simple one polymer approach was followed to create SWWs that do not require the removal of residual cladding material in experiment. The transmitted power from the SWWs was recorded during the writing process and then compared to the simulations. We achieved an experimental attenuation below 1 dB/cm for SWWs at a wavelength of 638nm which agree well with our numerical approach. In future, the developed approach will be applied to more complex structures and processes.

K 7.3 Wed 14:30 f428

Highly Efficient Rhodamine B Doped Polymer Fiber Lasers — •Stefanie Unland[1], Simon Spelthann[1,2], Jonas Thiem[1,2], Florian Jakobs[3], Jana Kielhorn[3], Pen Yiao Ang[3], Hans-Hermann Johannes[3,4,5], Dietmar Kracht[1,5], Jörg Neumann[1,5], Axel Ruehl[1,2,4], Wolfgang Kowalsky[3,4,5], and Detlev Ristau[1,2,4,5] — [1]Laser Zentrum Hannover e.V., Hannover, Germany — [2]Leibniz University Hannover, Institute of Quantum Optics, Hannover, Germany — [3]TU Braunschweig, Institut für Hochfrequenztechnik, Braunschweig, Germany — [4]Academic Alliance Braunschweig - Hannover QUANOMET, Germany — [5]Cluster of Excellence PhoenixD, Hannover, Germany

Rhodamine B (RB) doped polymer optical fiber amplifiers and lasers were already broadly investigated since the 1990s. New applications in the field of integrated photonics open new opportunities for the use of such fibers, e.g. lab-on-a-chip applications. As degradation of the dye or the polymer is expected during the manufacturing process, high efficiencies are desired to ensure lasing. To provide high energies, the performance of single-wavelength RB:POF lasers has to be optimized. We will present results on the optimization of a Rhodamine B doped poly(methyl-methacrylat) (PMMA) fiber laser which were achieved by varying the doping concentration and the output coupler reflectivity. High pulse energy of 1.65 mJ, a slope efficiency of 57%, and a half-life of 905000 pulses were achieved by pumping a 10 ppm doped fiber at a wavelength of 550 nm. Furthermore, simulations on the wavelength tunability of a laser based on such polymer fiber will be presented.

K 7.4 Wed 14:45 f428

Quantitative determination of molecules in cooling laser-induced plasmas — •Joshua Klose, Thomas Dietz, Peter Kohns, and Georg Ankerhold — University of Applied Sciences, RheinAhrCampus, Laser Spectroscopy and Photonics, Joseph-Rovan-Allee 2, 53424 Remagen

Laser induced plasma spectroscopy ("LIBS") is a promising method to determine the elemental contribution of samples which has found a lot of applications. While most LIBS analyses use the emission of atoms the quantitative analysis of molecular emission ("Molecular LIBS") can achieve additional information.

For example, the quantitative determination of atomic chlorine emission can be performed using atomic LIBS. However, this requires sophisticated setups under helium atmosphere. Very often the samples under examination contain Calcium. In this case in the generated LIBS plasma atomic chlorine and calcium form calcium-mono-chloride (CaCl) radicals which emit strongly in the visible range. No additional buffer gas is needed to acquire the CaCl emission which allows an indirect determination of the chlorine concentration within the sample.

While the simple observation of CaCl emission allows the qualitative detection of chlorine the determination of the intensity ratio of chlorine dependent and independent band emission can be used to create a linear calibration of the chlorine contamination. Thus, the quantitative determination of the chloride concentration becomes possible. As an application we show measurements obtained with chloride contaminated samples of concrete.