Fachverband Kurzzeitphysik (K)

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Übersicht der Hauptvorträge und Fachsitzungen

(Hörsaal HZO 40; Poster Foyer Audimax)

Hauptvorträge

K 1.1	Mo	13:30–14:05	HZO 40	**Warum ist das Licht so schnell ?** — •Rudolf Germer
K 1.2	Mo	14:05–14:40	HZO 40	**Moderne CMOS Bildsensoren und Kameras für wissenschaftliche Anwendungen** — •Gerhard Holst
K 3.1	Di	10:15–10:50	HZO 40	**Molecular Dynamics Simulation of Laser Ablation with the Two-Temperature Model** — •Johannes Roth, Alexander Kiselev, Dennis Rapp, Daniel Förster, Steffen Sonntag, Hans-Rainer Trebin
K 3.2	Di	10:50–11:25	HZO 40	**Tomography of laser-induced plasma using Radon transform technique for temporally and spatially resolved plasma diagnostics** — •Simon Eschlböck-Fuchs, Philipp Kolmhofer, Alexander Demidov, Igor B. Gornushkin, Thomas Schmid, Ulrich Panne, Roman Rössler, Norbert Huber, Johannes Heitz, Johannes D. Pedarnig

Hauptvorträge des fachübergreifenden Symposiums SYOT

Das vollständige Programm dieses Symposiums ist unter SYOT aufgeführt.

SYOT 1.1	Di	10:40–11:20	HZO 80	**Schichtsysteme für komplexe Anforderungen** — •Hans Becker
SYOT 1.2	Di	11:20–12:00	HZO 80	**Surface Reactivity of Sputtered Complex Metal Nitride Films in Oxygen Containing Environments - The Surface Near Region of TiAlN(O) Coatings** — •Guido Grundmeier, Christian Kunze, Martin Wiesing
SYOT 1.3	Di	12:00–12:40	HZO 80	**Pluto Plus: Erhöhung der Qualität und Ausbeute optischer Beschichtungstechnologien** — •Harro Hagedorn
SYOT 2.1	Di	14:00–14:30	HZO 80	**Charakterisierung des PIAD-Plasmas - aktueller Stand und neue Ansätze** — •Jens Harhausen, Detlef Loffhagen, Rüdiger Foest
SYOT 2.2	Di	14:30–15:00	HZO 80	**Untersuchungen an plasma-ionengestützt abgeschiedenen UV-Schichten auf Aluminiumoxidbasis** — •Christian Franke, Olaf Stenzel, Steffen Wilbrandt, Norbert Kaiser, Andreas Tünnermann
SYOT 2.3	Di	15:00–15:30	HZO 80	**Deposition von SiOx-Barriereschichten aus gepulsten Mikrowellenplasmen: Korrelation von Plasmadiagnostik und Schichtanalytik** — •Peter Awakowicz, Felix Mitschker, Simon Steves, Nikita Bibinov, Berkem Oezkaya, Guido Grundmeyer
SYOT 2.4	Di	15:30–16:00	HZO 80	**Ansätze für einen adaptiven Ionenstrahl-Zerstäubungs-Prozess (IBS)** — •Florian Carstens
SYOT 2.5	Di	16:30–17:00	HZO 80	**Prozessüberwachung und Prozessregelung auf Basis der Multipolresonanzsonde** — •Ralf Peter Brinkmann
SYOT 2.6	Di	17:00–17:30	HZO 80	**Computational approach to the design of amorphous metal oxide coatings for optical applications** — Thomas Frauenheim, •Thomas Köhler, Detlev Ristau, Henrik Ehlers, Marcus Turowski, Marc Landmann, Eva Rauls

Hauptvorträge des fachübergreifenden Symposiums SYLT

Das vollständige Programm dieses Symposiums ist unter SYLT aufgeführt.

SYLT 1.1	Mi	10:30–11:00	HZO 80	**Nichtlineare Optik mit ultra-breitbandigen Oszillatoren** — •Uwe Morgner, Tino Lang, Jan Ahrens, Yuliya Khanukaeva, Ihar Babushkin, Tamas Nagy
SYLT 2.1	Mi	11:30–12:00	HZO 80	**Laser in der Medizin** — •Christian Wüllner
SYLT 2.2	Mi	12:00–12:30	HZO 80	**Hochleistungs-Ultrakurzpulslaser für die Materialbearbeitung - Chancen und Herausforderungen** — •Arnold Gillner
SYLT 3.1	Mi	13:30–14:00	HZO 80	**Bandwidth limited ns and fs sources based on the Innoslab concept** — •Hans Dieter Hoffmann
SYLT 3.2	Mi	14:00–14:30	HZO 80	**Wellenfront-Messtechnik zur Charakterisierung von Optiken und Laserstrahlung** — •Klaus Mann
SYLT 3.3	Mi	14:30–15:00	HZO 80	**Femtosekundenfaserlaser: Technologie und Applikation** — •Martin Ruge
SYLT 3.4	Mi	15:00–15:30	HZO 80	**Eine neue kompakte, effiziente laserbasierte Weißlichtquelle für Kraftfahrzeugscheinwerfer (und andere Beleuchtungseinheiten)** — •Helmut Erdl, Abdelmalek Hanafi
SYLT 3.5	Mi	15:30–16:00	HZO 80	**Laser und Strahlformungssysteme zur Bearbeitung von Oberflächen und Dünnschichten** — •Jens Meinschien

Fachsitzungen

K 1.1–1.5	Mo	13:30–15:40	HZO 40	**Licht- und Strahlungsquellen, EUV**
K 2.1–2.1	Mo	15:40–16:00	HZO 40	**Pulsed Power**
K 3.1–3.6	Di	10:15–12:45	HZO 40	**Lasersysteme und deren Anwendungen I**
K 4.1–4.7	Di	14:00–16:20	HZO 40	**Lasersysteme und deren Anwendungen II**
K 5.1–5.4	Di	16:30–18:30	Foyer Audimax	**Poster**

Mitgliederversammlung Fachverband Kurzzeitphysik

Montag 16:30–17:00 HZO 40

- Bericht
- Verschiedenes

K 1: Licht- und Strahlungsquellen, EUV

Zeit: Montag 13:30–15:40 Raum: HZO 40

Hauptvortrag K 1.1 Mo 13:30 HZO 40

Warum ist das Licht so schnell ? — •Rudolf Germer — TU-Berlin — ITPeV,germer@physik.tu-berlin.de

Wenn es in der Welt nur ein einziges Elektron gäbe, brauchten wir keine Physik. Kräfte, Bewegung und zeitliche Veränderungen gibt es erst, wenn mindestens eine weitere Ladung oder ein Magnetfeld vorhanden sind. Ein Beispiel für eine elektromagnetische Welle, die sich nur in einer Dimension ausbreitet, liefert uns ein Impuls auf einer Leitung. Einen solchen Impuls können wir erzeugen, indem eine Gruppe von Elektronen während eines kurzen Zeitintervalls die Leitung auflädt. In der Weg-Zeit-Ebene breitet sich dieser Impuls dann auf der Lichtgeraden aus. Ergänzt man dieses Koordinatensystem mit einer dritten Achse *Strom* oder *Spannung*, dann liefern die Projektionen des Impulses auf die Ebenen mit der Zeitachse elektrische Ladung oder Magnetfluß und auf die Ebenen mit der Raumachse Polstärke (magnetischer Monopol) und elektrischem Fluß. All diese Größen sind gequantelt. Die Beziehungen dieser Quanten untereinander kann man mit einem elektromagnetischen Quader darstellen, der als Konstruktionselemente die Naturkonstanten Lichtgeschwindigkeit, Feinstruktur Konstante, Dielektrizitätszahl, magnetische Permeabilität, Klitzingwiderstand und Vakuumimpedanz enthält. Zusätzlich treten zwei Größen mit der Einheit Geschwindigkeit auf, deren Produkt das Quadrat der Lichtgeschwindigkeit liefert. Diese Größen können im Rahmen der "abzählbaren Physik" anschaulich auf elektromagnetische Trägheiten und Wechselwirkungen zurückgeführt werden.

Hauptvortrag K 1.2 Mo 14:05 HZO 40

Moderne CMOS Bildsensoren und Kameras für wissenschaftliche Anwendungen — •Gerhard Holst — PCO AG, Forschungsabteilung, Kelheim, Deutschland

Mittlerweile haben die CMOS Bildsensoren tatsächlich das erreicht, was sie seit vielen Jahre versprochen haben, nämlich die Bildqualität und die Leistungsparameter der vorher in den meisten wissenschaftlichen Kameras eingesetzten CCD Bildsensoren. Die CMOS und sCMOS Bildsensoren ermöglichen Anwendungen, die vormals gar nicht oder nur sehr zeitraubend möglich waren. Beispielhaft sind hier die scientific CMOS Bildsensoren zu sehen, die gerade neue Mikroskopie Verfahren verbessern. Zudem sind mit dem CMOS Herstellungsprozess auch besondere Funktionalitäten möglich, wie z.B. eine direkte Modulation der einzelnen Pixel. Im Vortrag wird am Beispiel von sCMOS und CMOS Bildsensoren, mit hoher Auflösung, hoher Bidlrate, hoher Empfindlichkeit, Modulierbarkeit gezeigt welche Richtungen derzeit im Bereich der Kamerasysteme für wissenschaftliche Anwendungen eingeschlagen und bearbeitet werden.

K 1.3 Mo 14:40 HZO 40

Plasma-based generation of ultra-short relativistic laser pulses via nonlinear parametric scattering — •Götz Lehmann, Friedrich Schluck, and Karl-Heinz Spatschek — Institut für Theoretische Physik I, Heinrich-Heine Universität, 40225 Düsseldorf, Germany

With current solid-state technology it is possible to generate laser pulses of few fs duration with up to a Petawatt peak power, intensities of 10^{22} W/cm^2 can be reached in the focal spot. Most of the high-power systems today are based on the chirped pulse amplification (CPA) technique, being limited in maximum intensity due to optical damage thresholds of the solid state components. However reaching intensities of 10^{25} W/cm^2 and beyond would open up the possibility to access for example nonlinear QED effects (e.g. pair-creation) directly with optical fields.

The use of plasma as an amplification medium is currently discussed because of the absence of a damage threshold in the classical sense. Via parametric scattering off a plasma oscillation the energy from a long pump pulse can be transferred into a short seed pulse, thus amplifying the seed. In the nonlinear regime the seed amplitude will become larger than that of the pump. The plasma oscillation can either be an electron Langmuir wave (Raman scattering) or a low frequency ion wave (Brillouin scattering).

We will present a short overview of possible amplification scenarios and motivate in particular our interest in (strongly-coupled) Brillouin scattering as a robust amplification process.

K 1.4 Mo 15:00 HZO 40

High-Harmonic Generation in Atomic Medium with a Sub-5-fs Multi-TW Optical Parametric Synthesizer System — •Daniel Rivas[1,2], Matthew Weidman[1], Boris Bergues[1], Alexander Muschet[1,2], Luisa Hofmann[1,2], Olga Razskazovskaya[2], Hartmut Schröder[1], Wolfram Helml[1], Gilad Marcus[1], Vladimir Pervak[2], Paris Tzallas[3], Dimitri Charalambidis[3], Ferenc Krausz[1,2], and Laszlo Veisz[1] — [1]Max-Planck-Institut für Quantenoptik, Garching, Germany — [2]Ludwig-Maximilians-Universität München, Garching, Germany — [3]Foundation for Research and Technology-Hellas, Heraklion, Greece

We report on the generation of high order harmonics in gas medium using a sub-5 fs multi-terawatt laser system based on optical parametric chirped pulse amplification. These high harmonics exhibit a quasi-continuous spectrum at photon energies tunable between 70-130 eV, allowing the isolation of pulses with durations in the order of a hundred attoseconds. An automated multi-dimensional phase-matching parameter scan leads routinely to pulse energies in the order of tens of nanojoules, making this an ideal source for attosecond XUV-pump XUV-probe experiments at these photons energies.

K 1.5 Mo 15:20 HZO 40

Plasma basierte Strahlquelle als intensiver Emitter für 6.x nm Strahlung — •Alexander von Wezyk und Klaus Bergmann — Fraunhofer Institut für Lasertechnik ILT, Aachen

Plasmen sind als intensive Strahlungsquellen für weiche Röntgen- und Extrem Ultraviolett Strahlung bekannt. So werden derzeit intensiv Laser und entladungsbasierte Konzepte für die kommende Generation der Chipproduktion bei einer Wellenlänge von 13.5 nm erforscht. Als möglicher Nachfolger dieser Technologie gilt die Produktion bei einer Zentralwellenlänge von 6.x nm. Im Vortrag wird das Potenzial verschiedener Emitter in Plasmen vorgestellt. Es wird ein Konzept auf Basis von einer Kryton Gasentladung ausführlicher diskutiert. Erste Ergebnisse bezüglich der spektralen Emission, Konversionseffizienz, Quellgröße, Brillanz und nutzbarer Inband-Strahlungsleistung (6.67 nm +/-0,6% b.w.) werden vorgestellt. In den beobachteten Emissionsspektren werden die erreichten Ionisationsstufen und Linienübergänge zugeordnet, woraus Rückschlüsse auf den Zustand des Plasmas gezogen werden. Die Auswirkung der Variation der Anlagenparameter auf den Plasmazustand wird anhand von Modelrechnungen abgeschätzt.

K 2: Pulsed Power

Zeit: Montag 15:40–16:00 Raum: HZO 40

K 2.1 Mo 15:40 HZO 40

Development of a light-gas gun as external driver for matter properties studies at GSI/FAIR — Michael Endres[1], Serban Udrea[2], Yana Hitzel[1], and •Dieter H.H. Hoffmann[1] — [1]Teschniche Universität Darmstadt, Darmstadt, Germany — [2]Goethe-Universität Frankfurt, Frankfurt, Germany

For first day experiments at the new ion accelarator facilty FAIR at GSI in Darmstadt a light-gas gun is in devolpment as external driver for shock-loading experiments. At FAIR a novel diagnostic system the proton microscope (PRIOR) will use high energy protons for radiography. Thus the ion accelerator will be used for accelerating the protons for diagnostics an external driver for creating of high energy density states is needed.

At the Technische Universität Darmstadt the design and realisation of a two stage light-gas gun as a driver for flyer acceleration is ongoing. The first stage consists of four pistons driven by methane combustion. These pistons compress and heat up Helium in the second stage. The Helium then is supposed to accelerate a sabot carrying a flyer. According to present estimations the two stage device could accelerate 3 g loads up to about 3 km/s. The flyers will shock load different types of targets. The resulting material states should be investigated by a combination of proton radiography and other means.

K 3: Lasersysteme und deren Anwendungen I

Zeit: Dienstag 10:15–12:45 Raum: HZO 40

Hauptvortrag K 3.1 Di 10:15 HZO 40

Molecular Dynamics Simulation of Laser Ablation with the Two-Temperature Model — •Johannes Roth, Alexander Kiselev, Dennis Rapp, Daniel Förster, Steffen Sonntag, and Hans-Rainer Trebin — Institut für funktionelle Materie und Quantentechnologien (FMQ), Universität Stuttgart

Laser treatment of surfaces has become an indispensable tool for modifying materials. Recently, new applications like micro-steering of satellites have come up.

Supported by the CRC 716, we have developed a molecular dynamics code for large scale simulations of femto-second pulses, taking into account the interaction of the laser with the charge carriers by an enhanced two-temperature model. The modification of the atomistic interaction by the laser irradiation is taken into account by electron-temperature dependent interactions. After introducing the model we will present results on simulations of simple metals, anisotropic alloys, and metallic multi-layer sheets and will discuss the behavior of double pulse sequences which show a decline of effectivity for delay intervals of about 10 ps. Results for covalent materials will also be presented, where there two-temperature model is expanded to describe varying carrier densities. The atomistic interaction is represented by an electron-temperature dependent modified Tersoff potential. The results show that both improvements are essential for good agreement with experimental data. We close by addressing further developments which are necessary to make the simulation code suitable for long laser pulses used in satellite steering.

Hauptvortrag K 3.2 Di 10:50 HZO 40

Tomography of laser-induced plasma using Radon transform technique for temporally and spatially resolved plasma diagnostics — •Simon Eschlböck-Fuchs[1], Philipp Kolmhofer[1], Alexander Demidov[3], Igor B. Gornushkin[2], Thomas Schmid[2], Ulrich Panne[3], Roman Rössler[4], Norbert Huber[1], Johannes Heitz[1], and Johannes D. Pedarnig[1] — [1]Institute of Applied Physics, Johannes Kepler University Linz, A-4040 Linz, Austria — [2]BAM Federal Institute for Materials Research and Testing, 12489 Berlin, Germany — [3]Humboldt-Universität zu Berlin, Department of Chemistry, 12489 Berlin, Germany — [4]voestalpine Stahl GmbH, A-4031 Linz, Austria

The Radon transform technique was employed to investigate the spatial distribution of emissivity of a laser induced plasma on metallurgical slag samples. Plasmas are ignited by single-pulses (SP), doublepulses (DP) in collinear geometry, and by the combination of a laser pulse with a pulsed arc discharge (SP-AD). The latter is formed by generating a SP plasma between two metal electrodes triggering a pulsed arc discharge. Angular and time-resolved plasma photography was carried out. The Radon transform technique was applied for a three-dimensional reconstruction of plasma emissivity. The measurements were conducted for different delay times with respect to the laser pulse, ranging from a few microseconds for SP and DP up to tens of microseconds for SP-AD. Results for the plasma emissivity and shape are compared, revealing a more homogeneous distribution of emissivity for DP and SP-AD excited plasma.

K 3.3 Di 11:25 HZO 40

Erhöhung der Nachweisempfindlichkeit in der laserinduzierten Plasmaspektroskopie (LIBS) über die zeitaufgelöste Messung molekularer Emissionsbanden — Georg Ankerhold, •Anne-Sophie Rother und Peter Kohns — Hochschule Koblenz - RheinAhrCampus, Laserspektroskopie und Photonik, Joseph-Rovan-Allee 2, 53424 Remagen

Bisher wurde in der laserinduzierten Plasmaspektroskopie (LIBS) nur nach charakteristischen Emissionslinien neutraler oder ionisierter Atome gesucht, um damit chemische Elemente in verschiedenen Proben zu identifizieren und Mischungsverhältnisse quantitativ bestimmen zu können. Der Grund für eine ausschließliche Atom- und Ionenspektroskopie besteht darin, dass durch die hohe Temperatur der Gasphase über 10 000 K verbunden mit einer Ionisierung des Probenmaterials alle chemischen Bindungen aufbrechen. Untersuchungen unserer Arbeitsgruppe zeigen jedoch, dass in der Abkühlphase des laserinduzierten Mikroplasmas auch chemische Verbindungen entstehen können, die sich weitaus besser für die quantitative Elementanalyse eignen. Die sich bildenden zweiatomigen Radikale besitzen eigene spezifische molekulare Emissionsbanden, die zum Teil deutlich stärker sind als die Emissionslinien der Einzelelemente und häufig in einem für Spektrometer günstigeren Spektralbereich liegen. Am Beispiel der Halogene Fluor und Chlor zeigen wir die deutliche Senkung der Nachweisgrenze und die Verbesserung der Messgenauigkeit. Auf interessante Anwendungsmöglichkeiten im industriellen Analysebereich wird hingewiesen.

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K 3.4 Di 11:45 HZO 40

Laser-induced breakdown in an aluminum thin film and subsequent shock wave propagation in mini capillary — •Yun Kai[1], Walter Garen[1], Johannes Diekhoff[1], and Ulrich Teubner[1,2] — [1]Institut für Laser und Optik, Hochschule Emden/Leer, Constantiaplatz 4, 26723 Emden — [2]Institut für Physik, Carl von Ossietzky Universität Oldenburg, 26111, Oldenburg

A femtosecond-laser induces an optical breakdown in a thin aluminum film. As a consequence, an initially spherical shock wave is generated. The shock wave is coupled into a glass capillary (diameter of 0.75 mm or 0.5 mm, respectively). It is known that in free air, the initial shock wave will be decelerated to sound speed after propagating through a small distance of several millimeters. Due to the three dimensional propagation, the shock wave loses its kinetic energy quickly. In contrast to free air, the shock wave can propagate a much longer distance (several dozens of millimeters) in a capillary, which enables a quasi one dimensional propagation. Furthermore compared to breakdown in air, the breakdown in a solid state target (in the present study, Al films with a thickness in the range of 30-200 nanometers) can generate a much stronger shock wave. The shock wave velocities at different propagation distances are determined by a laser differential interferometer (LDI). The shock wave reflections and the boundary layer development inside the capillary are also investigated by the LDI and a schlieren setup.

K 3.5 Di 12:05 HZO 40

Laser-induced breakdown spectroscopy of major and minor elements in steel slags: Influence of background gas and detection geometry — •Christoph M Ahamer[1], Simon Eschlböck-Fuchs[1], Philipp J Kolmhofer[1], Roman Roessler[2], Norbert Huber[1], and Johannes D Pedarnig[1] — [1]Institute of Applied Physics, Johannes Kepler University Linz, A-4040 Linz, Austria — [2]voestalpine Stahl GmbH, A-4031 Linz, Austria

Slag from secondary metallurgy in industrial steel production is analyzed by laser-induced breakdown spectroscopy (LIBS). The optical emission of laser-induced plasma on slags is measured in different background gases and for different detection geometries. The major oxides are quantified by calibration-free LIBS (CF-LIBS) method. For one minor oxide calibration curves are established using different reference signals. Our results show that light detection by direct coupling to an optical fiber that is close to the plasma ('direct') and by collinear coupling in backward direction to a fiber at larger distance ('collinear') delivers very similar LIBS spectra, plasma parameters, and analytical results. LIBS spectra measured in different background gases (air, N2, Ar, He) are similar for direct and collinear detection. For the quantification of minor components and the limit of detection the background gas and the reference signal are found to be important. Acknowledgements: Financial support by the Austrian Research Promotion Agency FFG (Project 838861) is gratefully acknowledged.

K 3.6 Di 12:25 HZO 40

Molecular Dynamics Simulations of Laser Ablation in Silicon:

the Influence of Electron-Temperature dependent Interactions — •Alexander Kiselev, Johannes Roth, and Hans-Rainer Trebin — Institut für Funktionelle Materie und Quantentechnologien, Universität Stuttgart, Germany

The well-known continuum two-temperature model for solids with highly excited electrons is extended from metals to semiconductors. It is combined with classical molecular dynamics simulations to study laser ablation in semiconductors where the charge carriers are created by the absorption of the laser light. The model is further enhanced by extending the static modified Tersoff potential [1] to a dynamical interaction which depends on the electron temperature of the material. At the opposite side of the irradiated surface pressure-transmitting [2] boundary conditions are applied to prevent reflections of the laser-induced pressure waves. Results are presented for single and multiple pulses in silicon film at different laser fluences.

[1] T. Kumagai, S. Izumi, S. Hara and S. Sakai, Comput. Mater. Sci. **39**, 457-464 (2007)
[2] L.V. Zhigilei, B.J. Garrison, Mater. Res. Soc. Symp. Proc. **538**, 491-496 (1999)

K 4: Lasersysteme und deren Anwendungen II

Zeit: Dienstag 14:00–16:20 Raum: HZO 40

K 4.1 Di 14:00 HZO 40

Intracavity phase and amplitude manipulation of a femtosecond semiconductor laser system — •Rouven H. Pilny, Benjamin Döpke, Carsten Brenner, Jan C. Balzer, and Martin R. Hofmann — Ruhr-Universität Bochum, Germany

The huge progress in the field of femtosecond pulses has enabled a wide range of new applications such as two-photon microscopy or the generation of THz-radiation. State of the art sources for ultra-short pulses are solid state laser systems or fiber lasers. While solid state lasers have a complex setup and fiber lasers are limited in their wavelength, semiconductor laser systems can be miniaturized, are very cost-efficient and are variable in their wavelength by choice of material and design. However, semiconductor lasers are not commercially available sources for ultra-short pulses. The reason is that the spectral bandwidth of emitted pulses typically utilizes only a fraction of the possible gain spectrum. Because of the correlation between the spectral bandwidth and pulse duration described by the Fourier-transformation, this results in pulses much longer than the physical limits. Our approach to solve this problem is the introduction of intracavity dispersion management (IDM). This is done by using a Spatial Light Manipulator in an external cavity. We demonstrate that by introducing a combination of quadratic and cubic phase, we can produce a higher spectral bandwith and therefore shorter pulses. After external compression, we could reduce the pulse duration from 1.6 ps without IDM to 437 fs with IDM. In addition, the manipulation of the amplitude proved to further shorten the generated pulses.

K 4.2 Di 14:20 HZO 40

Towards an Ytterbium based frequency synthesizer — •Anne-Laure Calendron[1,2], Huseyin Cankaya[1,2], Luis Zapata[1,2,3], Hua Lin[3], Giovanni Cirmi[1,2], Giulio Rossi[1,2], Oliver Mücke[1,2], and Franz 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, Universität Hamburg, Hamburg, Germany — [3]Department of Electrical Engineering and Computer Science and Research Laboratory of Electronics, MIT, Cambridge, USA

Attosecond pulses are sought for experiments enlightening intra-atomic and intermolecular phenomena in attosecond or femtosecond time scale. These pulses can currently only be obtained via high-harmonics generation in gases. Here, we present the first developments of a laser driver system for these applications, delivering a broadband spectrum covering several octaves with high energy: a waveform synthesizer based on parallel amplification.

A broadband, low energy pulse generated via passively CEP stable white-light generation will be split spectrally into several channels and parametrically amplified to higher energies. The CEP-stable white-light is driven by a sub-picosecond Yb:KYW regenerative amplifier. The first stages of the parametric amplification will be pumped with the remaining energy from the regenerative amplifier and the last ones with the output of a cryogenically cooled Yb:YAG composite thin-disc amplifier. The technique for the recombination of the channels to generate a sub- to single cycle pulse will be finally discussed.

K 4.3 Di 14:40 HZO 40

Femtosecond probing of fast transient plasma processes in high-power laser interaction with solids — •Thomas Kluge[1], Lingen Huang[1], Christian Gutt[2], Michael Bussmann[1], Hyun Chung[3], Malte Zacharias[1], Ulrich Schramm[4], and Thomas Cowan[4] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]Universität Siegen — [3]International Atomic Energy Agency — [4]Helmholtz-Zentrum Dresden-Rossendorf und TU Dresden

Ultra-intense laser-matter interactions are a major research area in in modern plasma physics. One of the essential elements is the relativistic electron generation and transport dynamics. At present, a predictive understanding of high-intensity laser-matter interactions is severely hampered by the lack of self-consistent models for the ionization dynamics, coupled with the complex electron transport.

We establish the feasibility of using XFEL femtosecond X-ray sources to probe the spatial correlations inside of the solid-density plasma using small angle X-ray scattering (SAXS) and resonant SAXS, to obtain for the first time information on the spatial and temporal evolution of the electron density and ionization dynamics with few fs and few nm resolution. The local and instantaneous ionization state can be measured when the X-ray beam is tuned to a bound-bound resonance of a particular charge state. The atomic scattering factor at the threshold of core electron excitation increases for example at Kα excitations in highly ionized Cu to a magnitude of more than 100 times the Thomson cross section per ion.

K 4.4 Di 15:00 HZO 40

Vergleich zeitaufgelöster Emissionsspektroskopie an transienten Plasmen bei Laserpuls und Hochgeschwindigkeitsimpakt — •Dominic Heunoske, Jens Osterholz, Martin Schimmerohn, Frank Schäfer und Matthias Wickert — Fraunhofer EMI, Freiburg, Deutschland

Die vorliegende Arbeit untersucht die Dynamik von Plasmen, die bei der Wechselwirkung von Nanosekunden-Laserpulsen mit Materie beziehungsweise beim Hochgeschwindigkeits-Impakt erzeugt werden. Es wird die zeitaufgelöste Spektroskopie zur Diagnostik der Plasmaparameter eingesetzt. Mit einem Messsystem bestehend aus Spektrograph und Streak-Kamera wurden zeitaufgelöst jeweils die Emissionsspektren von Plasmen mit einer Lebensdauer von wenigen Mikrosekunden aufgezeichnet. Zur Auswertung der experimentellen Daten wurde ein Modell entwickelt, das es erlaubt, die maßgeblichen Plasmaparameter Elektronendichte und Elektronentemperatur für optisch dicke und dünne Plasmen zu bestimmen und so zeitabhängige Informationen über die transienten Plasmen zu erhalten. Für den Fall eines optischen dichten Plasmas wird der Strahlungstransport im Plasma berücksichtigt und in Abhängigkeit von Elektronendichte und Temperatur ein Emissionsspektrum simuliert. Für optische dünne Plasmen werden Elektronendichte und Elektronentemperatur aus der Linienbreite bzw. dem Verhältnis von Linien- zu Kontinuumsstrahlung ermittelt. Die Dynamik von Laser-produziertem Plasma und Impaktplasma wird verglichen.

K 4.5 Di 15:20 HZO 40

Eisen-Nanopartikelgenerierung durch fs-Laserabtrag in Flüssigkeiten — •Alexander Kanitz, Andreas Ostendorf und Evgeny Gurevich — Ruhr-Universität Bochum, Laseranwendungstechnik, 44801 Bochum, Deutschland

Durch Femtosekundenlaserabtrag von dünnen Schichten oder Bulkmaterial in Flüssigkeiten lassen sich Nanopartikel herstellen. Durch die hohen Leistungsdichten beim Ultrakurzpulslaserabtrag von 10^{12} bis 10^{17} W/cm^2 entsteht ein Metallplasma an der Targetoberfläche aus dem die Nanopartikel kondensieren können. Die Nanopartikel liegen dabei dispers und ligantenfrei in Lösung vor, ohne toxische Prekursoren zu benötigen. Insbesondere die chemische Reaktivität von Eisen bestimmt die Eigenschaften der Nanopartikel. Durch die geeignete Wahl der Laserparameter und Flüssigkeit können diese kontrolliert werden. Die Einflüsse der verschiedenen Parameter auf die Nanopartikeleigenschaften und Zusammensetzung sowie auf das generierte Metallplasma werden in diesem Beitrag vorgestellt.

K 4.6 Di 15:40 HZO 40

Terahertz time domain spectrometer to characterize nonlinear materials for efficient terahertz generation — •Frederike Ahr[1,2], Sergio Carbajo[1,2], Giovanni Cirmi[1], Oliver D. Mücke[1], Xiaojun Wu[1], and Franz X. Kärtner[1,2,3] — [1]Center for Free Electron Laser Science, and Deutsches Elektronen Synchrotron, Notkestraße 85, 22607 Hamburg, Germany — [2]Department of Physics, University of Hamburg, 22761 Hamburg, Germany — [3]Department of Electrical and Computer Engineering, and Research Laboratory of Electronics, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, Massachusetts 02139, USA

Strong-field THz radiation is essential to several applications such as terahertz (THz) time-resolved spectroscopy and electron acceleration. Optical rectification in nonlinear materials such as lithium niobate (LN), lithium tantalate (LT) and serveral organic crystals, hold promise in energy scalabilty of single-cycle THz generation. Fundamental properties of these materials are yet unexplored or poorly reported in this wavelength regime. We investigate the spectroscopic properties of nonlinear materials employed for broadband THz generation with an in-house THz time-domain spectrometer (THz-TDS) -based on a 85 MHz Ti:Sapphire oscillator with 400 mW average power and 50 fs pulse duration. We employ our THz-TDS to study the absorptive, reflective, and amplitude/phase properties of LN and LT at cryogenic- and room-temperature. We also report experimental results of strong-field THz generation optimized from our nonlinear materials study.

K 4.7 Di 16:00 HZO 40

Real-Time Observation of Transient Electron Density in High Band Gap Materials Irradiated with Tailored Femtosecond Laser Pulses — •Cristian Sarpe, Thomas Winkler, Jens Köhler, Nikolai Jelzow, Nadine Götte, Bastian Zielinski, Arne Senftleben, and Thomas Baumert — University of Kassel, Institute of Physics and CINSaT, D-34132 Kassel, Germany

The first step in laser ablation of high bandgap materials is the generation of a high density free electron plasma. We have shown that tailored ultrashort laser pulses are suitable for robust manipulation of optical breakdown. By using these pulses the precision of femtosecond-laser machining results in microstructures one magnitude order below the optical diffraction limit [1, 2, 3]. Here we present our studies to investigate the early-time dynamics of a free electron plasma created by shaped femtosecond laser pulses in water, as a prototype for high bandgap materials, by using a robust spectral interference technique with an enlarged temporal measurement window [4]. The phase shift between a reference and a probe pulse produced in a common-path interferometer gives accurate information about the density of the free electron plasma. The temporal evolution of the plasma is accurately observed and its dependence on the laser intensity and temporal pulse shapes is analyzed. [1] L. Englert et al., Opt. Expr. 15, 17855 (2007) [2] L. Englert et al. JLA 24, 042002 (2012) [3] M. Wollenhaupt et al., JLMN (2009) 4 (3) 144-151 [4] C. Sarpe et al., NJP 14, 075021 (2012)

K 5: Poster

Zeit: Dienstag 16:30–18:30 Raum: Foyer Audimax

K 5.1 Di 16:30 Foyer Audimax

Nanosecond pulsed electric fields decrease cell elasticity — •Anna Steuer[1], Malte U. Hammer[1,2], and Juergen F. Kolb[1] — [1]Leibniz Institute for Plasma Science and Technology (INP), Greifswald — [2]Center for Innovation Competence (ZIK), Greifswald

The exposure of cells to nanosecond pulsed electric fields (nsPEF) can cause different effects, depending on pulse length and field strength. Currently, nsPEF are investigated as a novel cancer therapy. As invasive cell lines generally display a lower elastic modulus than their non-invasive counterparts, we investigated the effect of nsPEF on the elasticity of rat liver epithelial WB-F344 cells in a monolayer and compared the elasticity to untreated cells and their tumorigenic counterpart WB-ras. Force-distance curves were recorded with an atomic force microscope (AFM) and the applied force was plotted against indentation of the cantilever.

We found that cells treated with 20 pulses of 100 ns and 20 kV/cm have almost the same elasticity as the tumorigenic WB-ras cells but are softer than untreated WB-F344 cells. Furthermore, we stained the actin cytoskeleton and performed a soft agar colony formation and a migration assay. Preliminary results did not show any changes. Although cell elasticity is decreased after nsPEF treatment, cells seem not to become tumorigenic or migrate faster.

K 5.2 Di 16:30 Foyer Audimax

Combination of pulsed electric fields and non-thermal plasma jet for more effective bacterial decontamination — •Jana Kredl, Qian Zhang, Jie Zhuang, Anna Steuer, and Juergen F. Kolb — Leibniz Institute for Plasma Science and Technology (INP Greifswald e.V.)

Exposures to pulsed electric fields and non-thermal plasmas have both been investigated as methods for the inactivation of microorganisms. In our studies we have combined treatments with an argon-operated, rf-driven plasma jet (kINPen 09) with the application of pulsed electric fields of microsecond duration. Inactivation efficacy against Gram-positive Staphylococcus aureus and Gram-negative Pseudomonas aeruginosa was determined by viability counts. Treatments of 3 minutes with plasma alone, or treatments with consecutive pulsed electric fields of 100 microseconds duration and 15-kV/cm amplitude alone, were found to result in some but not complete inactivation. Conversely, a combination of treatments exhibits significant synergies versus individual treatments, resulting in a complete inactivation when bacteria suspensions are first treated with the plasma. Membrane integrity, membrane potential and intracellular ROS were studied by flow cytometry. Leakage of intracellular compounds, such as DNA and protein, was measured spectrophotometrically at 260 nm and 280 nm. The properties of the cell suspension, such as pH-value, conductivity, and RNS&ROS, were also investigated. Studies of the underlying mechanisms suggest that in the plasma activated liquid environment, cells become more vulnerable to electroporation.

K 5.3 Di 16:30 Foyer Audimax

Dielectric Investigation of Normal and Malignant Cells Exposed to Nanosecond Pulsed Electric Field — •Jie Zhuang, Anna Steuer, and Juergen F. Kolb — Leibniz Institute for Plasma Science and Technology, Greifswald, Germany

Nanosecond pulsed electric field (nsPEF) has shown its unique potential as a non-thermal tumor ablation method. A number of studies have confirmed that nsPEF can induce apoptosis of many types of cancer cells. However little is known about the responses of normal cells when exposed to apoptosis-inducing nsPEFs. For in vivo applications, this is a crucial question to answer. It is generally believed that normal and cancer cells exhibit very different dielectric characteristics which initiate different nsPEF-cell interactions and lead to different cell fate. To the best of our knowledge, this topic has not been thoroughly explored. In this study, the responses of a normal rat liver epithelial cell line (WB-F344) and its malignant counterpart (WB-ras) to nsPEFs were investigated by means of dielectric spectroscopy. Preliminary results show that normal and cancer cells exhibit significantly different dielectric characteristics. Using a well established tissue model (cell monolayer), we found that the long-term (24 hours) influence of nsPEFs on the dielectric properties of normal cells is significantly weaker than on cancer cells, suggesting normal cells recover faster from nsPEF-exposures.

K 5.4 Di 16:30 Foyer Audimax

A New Scheme for High-Intensity Relativistic Laser-Driven Acceleration of a Relativistic Electron in a Plasma — •Saltanat P. Sadykova[1], Anri A. Rukhadze[2], and T.G. Samkharadze[3] — [1]Forschungszentrum Julich, Jülich Supercomputing Center, Jülich, Germany — [2]Prokhorov General Physics Institute, Russian Academy of Sciences, Vavilov Str. 38., Moscow — [3]Moscow State University of Instrument Engineering and Computer Science Moscow

We propose a new approach to high-intensity relativistic laser-driven electron acceleration in a plasma [1]. Here, we demonstrate that a plasma wave generated by a stimulated forward-scattering of an incident laser pulse can be in the longest acceleration phase with injected relativistic beam electrons. This is why the plasma wave has the maximum amplification coefficient which is determined by the acceleration time and the breakdown (overturn) electric field in which the acceleration of the injected beam electrons occurs. We must note that for the longest acceleration phase the relativity of the injected beam electrons plays a crucial role in our scheme. We estimate qualitatively the acceleration parameters of relativistic electrons in the field of a plasma wave generated at the stimulated forward-scattering of a high-intensity laser pulse in a plasma.

[1 A. A. Rukhadze, S. P. Sadykova, T. G. Samkharadze, P. Gibbon, arXiv:1404.6589