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 Kontinuumstrahlung 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)