K 6: Poster

Time: Wednesday 16:15–18:15 Location: Orangerie

K 6.1 Wed 16:15 Orangerie

Plasma shock wave simulation for laser shock processing — •Vasily Pozdnyakov and Jens Oberrath — Institute of Product and Process Innovation, Leuphana University Lüneburg, Germany

Improvement of mechanical properties such as fatigue life, corrosion, wear and erosion resistance of material surfaces has become an integral part of industrial operations. Laser shock peening (LSP) is one of the advanced surface modification techniques. When focusing a short (ns range) and intense (>1 GW/cm2) laser pulse onto a metallic target, surface layers instantaneously vaporize into a high temperature (about 10 000 K) and high pressure (> 1 GPa) plasma. This plasma induces a shock wave during expansion from the irradiated surface and a mechanical impulse transfers to the target resulting in plastic deformations and residual stresses appear.

In this work a 1D model, based on a global model of Zhang et al. [1, 2], is implemented in Python. As a result of its numerical solution the influence of laser parameters on the results of processing is investigated. Pressure distribution and plasma parameters are defined and compared both with experimental results and numerical models of other researchers.

[1] W. Zhang and Y.L. Yao, Proceedings of the ICALEO 2001

[2] W. Zhang, Y.L. Yao, I.C. Noyan, J. Manuf. Sci. E. - T. ASME 126, 10 (2004)

K 6.2 Wed 16:15 Orangerie

Laser processing of silicon suboxide for the fabrication of diffractive phase elements — •Lukas Janos Richter, Clemens Beckmann, Jörg Meinertz, and Jürgen Ihlemann — Laser-Laboratorium Göttingen e.V., Hans-Adolf-Krebs-Weg 1, 37077 Göttingen

Matierals processing by UV excimer laser ablation offers fast and flexible ways for microfabrication. A prerequisite for precise patterning is strong absorption in the UV regime. In contrast to UV-transparent fused silica (SiO_2), silicon suboxide (SiO_x, $x<2$) is absorbing in the UV and can be machined with high precision. By thermal treatment the silicon suboxide can subsequently be oxidised to fused silica. This two step process allows for the fabrication of microstructured components made entierly of fused silica. E. g., diffractive optical elements with two phase-quantized levels (binary DOEs) can be produced via rear-side ablation of a thin film of silicon suboxide on a fused silica substrate [1]. In a next step a multilevel structure is produced by repeating the steps of ablation and oxidation after recoating the surface with silicon suboxide.

[1] Fricke-Begemann et al., Applied Physics A 117:13-18 (2014)

K 6.3 Wed 16:15 Orangerie

Time resolved coherent lensless imaging of plasma dynamics — •Elisa Appi[1], Ahmed Maghraoui[2], Willem Boutu[2], Hamed Merdji[2], and Milutin Kovacev[1] — [1]Institut für Quantenoptik, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover — [2]LIDYL Laboratory CEA-Saclay, 91191 Gif-sur-Yvette, France

Coherent lensless imaging is a powerful technique that offers spatial resolution at the order of the wavelength, thanks to the fact that no optical elements are required. The capability of imaging objects with nanometric spatial resolution and on femtosecond time scales in a single shot mode has been demonstrated [1]. Here we present a pump-probe setup to perform coherent diffractive imaging with time resolution from the few-femtosecond scale up to nanoseconds to measure the laser driven plasma dynamics in for example Titanium spheres. After the interaction with an ultrashort pump pulse which enables the dynamics, the samples are illuminated by an intense XUV coherent beam with high photon flux. Using the technique of holography with extended references (HERALDO) it is possible reconstruct the final image from the recorded diffraction patter in a more efficient way [2] than standard Fourier transform holography. The temporal resolution should allow to observe the very early stage of the plasma heating, phase transitions and plasma expansion which conventional light microscopy techniques cannot resolve.

[1] A. Ravasio *et al.*, Phys. Rev. Lett. **103**, 028104 (2009).

[2] D. Gauthier *et al.*, Phys. Rev. Lett. **105**, 093901 (2010).

K 6.4 Wed 16:15 Orangerie

Femtosecond mode-locked Ti:Sapphire laser pumped by the 461 nm laser diode — •Denis A. Kopylov[1], Tatiana V. Murzina[1], Aleksandr V. Konyashchenko[2], and Anton I. Maydykovskiy[1] — [1]Physics Department, Moscow State University, 119991 GSP-1, Leninskie Gory, Moscow, Russia — [2]P.N. Lebedev Physics Institute, Russian Academy of Sciences, Leninskiy prosp 53, 119991 Moscow, Russia

One of the most widely used femtosecond solid-state lasers is based on a titanium-doped aluminum oxide crystal (Ti:Sapphire), possessing a wide fluorescence spectra ranging from 690 nm up to 1050 nm, which allows to create continuous wave and the Kerr-lens mode-locked lasers with the pulse duration from 5 fs up to 150 fs as well. The absorption spectrum of the Ti:Sapphire crystals corresponds to the spectral range 450-530 nm. Thus pumping of a Ti:Sapphire laser can be realized by using blue laser diodes. The laser diode beam profile is elliptical with a strong astigmatism. Therefore the beam correction schemes have to be developed for effective pumping of the Ti:Sapphire oscillator.

We demonstrate the mode-locked Ti:Sapphire oscillator pumped by a single diode laser (461 nm, 4 W) with the M^2 equal to 2.6 and 11.8 for the fast and slow axes, respectively. We successfully demonstrate the CW and Kerr-lens mode-locked regimes of operation of laser diode pumped Ti:Sapphire with 3 mm, 5 mm and 10 mm length crystals. The pulses as short as 15 fs and a power of 170 mW are presented. The factors that have an effect on efficiency of Ti:Sapphire laser pumped by the laser diode are analyzed.

K 6.5 Wed 16:15 Orangerie

The Small Quantum Systems - SQS Instrument at the European XFEL — •Patrik Grychtol, Alexander Achner, Thomas Baumann, Rebecca Boll, Alberto De Fanis, Sascha Deinert, Markus Ilchen, Tommaso Mazza, Jacobo Montano, Yevheniy Ovcharenko, Nils Rennhack, Rene Wagner, Pawel Ziolkowski, and Michael Meyer — Small Quantum System Group, European XFEL GmbH, Holzkoppel 4, 22869 Schenefeld

This contribution presents the Small Quantum System (SQS) scientific instrument, which is one of six experimental end stations at the European XFEL. This experimental platform is designed for investigations of atomic and molecular systems, as well as clusters, nano-particles and small bio-molecules. It is located behind the SASE 3 soft x-ray undulator, which will provide horizontally polarized FEL radiation in a photon energy range between $260\,eV$ and $3000\,eV$ ($4.8\,nm$ to $0.4\,nm$) with 0.1 to 2×10^{14} photons per pulse and up to 27000 pulses per second. Two high-quality elliptical mirrors in Kirkpatrick-Baez configuration will focus the FEL beam to a FWHM spot size of approximately $1\,\mu m$ diameter. This is going to result in an intensity of more than $10^{18}\,W/cm^2$ within the interaction region, which will allow for studying non-linear multi-photon processes. Furthermore, the short FEL pulse duration between $2\,fs$ and $100\,fs$ in combination with a synchronized optical femtosecond laser will enable time-resolved studies of dynamic processes, thus capturing the motion of electrons and nuclei with unprecedented resolution in space on ultrafast time scales.

K 6.6 Wed 16:15 Orangerie

Investigating Resonant Two-Color Photoionization Processes in Atoms and Molecules — •Rene Wagner, Alexander Achner, Thomas Baumann, Rebecca Boll, Alberto De Fanis, Sascha Deinert, Patrik Grychtol, Markus Ilchen, Tommaso Mazza, Jacobo Montano, Yevheniy Ovcharenko, Nils Rennhack, Pawel Ziolkowski, and Michael Meyer — Small Quantum System Group, European XFEL GmbH, Holzkoppel 4, 22869 Schenefeld

We present an experimental tabletop set-up dedicated to investigations of ultrafast processes in atoms and molecules combining near infrared (NIR) and extreme ultraviolet (EUV) radiation pulses. Our experiments will focus on the study of electron correlations in highly excited auto-ionizing resonances by different pump-probe techniques aiming to obtain novel insights into atomic and molecular dynamics. For this purpose, a femtosecond laser driven EUV source based on high harmonic generation (HHG) is employed in combination with a pulsed molecular jet, a delay-line based velocity map imaging (VMI) detector and a time-of-flight (TOF) spectrometer. We are going to show first results quantifying the performance of our experimental apparatus having captured and analysed the angular electron distributions of the auto- and cross-correlations with our ultrafast NIR and EUV pulses in atomic argon, respectively.

K 6.7 Wed 16:15 Orangerie

Synchronous VUV light source for FLASH II

— •Elisa Appi[1], Eike Lübking[1], Tino Lang[2], Christoph Heyl[2], Ingmar Hartl[2], Robert Moshammer[3], Uwe Morgner[1], and Milutin Kovacev[1] — [1]Institut für Quantenoptik, Leibniz Universität Hannover, Welfengarten 1, 30167 Hannover — [2]DESY, Notkestrasse 85, D-22607 Hamburg — [3]Max Planck Institute of Nuclear Physics, D-69117 Heidelberg

The design of a VUV radiation source, based on high harmonic generation (HHG), is presented. Driven by 700-900nm femtosecond laser pulses and their harmonics, it will generate femtosecond pulses with photon energies between 10 and 40 eV. The source will be installed as a permanent device for the free electron laser FLASH II at DESY and the VUV pulses will be optically synchronized with the FLASH burst. The challenge of the project is the high pulse repetition rate in the burst of the FLASH, which limits the pulse energy of the IR driver. Due to the low available pump energy a highly efficient HHG process is required and different HHG schemes are been evaluated to obtain the highest photon fluxes in the spectral range of interest. First experiments on single-molecule spectroscopy will be performed on the installed reaction microscope (REMI) using the new VUV-FLASH pump-probe capabilities.

K 6.8 Wed 16:15 Orangerie

Soliton-effect self-compressed single-cycle 9.6 W mid-IR pulses from a OPCPA at 3.25 μm and 160 kHz

— •Alexey Ermolov[2], Ugaitz Elu[1], Matthias Baudisch[1], Hugo Pires[1], Francesco Tani[2], Michael H. Frosz[2], Felix Köttig[2], Philip St.J. Russell[2], and Jens Biegert[1,3] — [1]ICFO - Institut de Ciencies Fotoniques, The Barcelona Institute of Science and Technology, 08860 Castelldefels (Barcelona), Spain — [2]Max Planck Institute for the Science of Light, Staudtstraße 2, 91058 Erlangen, Germany — [3]ICREA, Pg. Lluís Companys 23, 08010 Barcelona, Spain

Gas-filled hollow-core photonic crystal fiber (HC-PCF) has been successfully used, over a broad range of laser wavelengths, for compressing laser pulses in the micro-Joule energy range down to single cycle durations. Here we report compression, in a gas-filled HC-PCF, of pulses from a mid-IR optical parametric chirped pulse amplifier. The results out-perform previous systems by more than an order of magnitude, achieving peak powers of 3.9 GW at a 160 kHz repetition rate with intrinsically carrier envelope phase-stable pulses near the single-cycle limit. The 97 fs pulses at the laser output were compressed down to 14.5 fs (corresponding to 1.35 cycles) using soliton dynamics in a HC-PCF filled with argon. The compression scheme was remarkably efficient, introducing only 20% loss, thereby yielding 60 μJ output energy pulses at 3.3 μm with 9.6 W average power. This system presents a significant step forward in the generation of coherent hard x-rays and subsequent access to the zeptosecond regime of light-matter interactions.

K 6.9 Wed 16:15 Orangerie

Zeitaufgelöste interferometrische Diagnostik an einem Plasmastripper

— •Philipp Christ, Konstantin Cistakov, Marcus Iberler und Joachim Jacoby — Goethe-Universität Frankfurt, Institut für Angewandte Physik, Plasmaphysik

Die interferometrische Plasmadiagnostik zeichnet sich als Messtechnik mit aktiver elektromagnetischer Strahlung durch eine hohe Genauigkeit, hohe Zeitauflösung und durch vielseitige Anpassbarkeit an die Experimentbedingungen aus. Darüber hinaus bietet sie die Möglichkeit eine zeitaufgelöste Magnetfeldmessung simultan zur Messung der Elektronendichte durchzuführen. Durch diese Vorteile hebt sie sich von Messtechniken mit passiver elektromagnetischer Strahlung, wie die Spektroskopie, ab.

Dieser Beitrag soll von der Problemstellung ausgehend das Konzept aufzeigen, wie eine interferometrische Diagnostik in der Praxis umgesetzt werden könnte. Dabei soll das Interferometer das heterodyne Messverfahren nutzen, wobei die notwendige Frequenzverschiebung akusto-optisch erzeugt wird. Des Weiteren soll eine kollineare Zwei-Farben-Vibrationskompensation zum Einsatz kommen, bei welcher die Problematik der akusto-optischen Dispersion durch einen AOTF (Acousto-Optical Tunable Filter) umgangen werden soll.