Q 14: Ultrakurze Pulse: Erzeugung II

Zeit: Montag 16:30–18:45 Raum: VMP 8 R206

Q 14.1 Mo 16:30 VMP 8 R206

Large bandwidth highly efficient dielectric gratings through high index materials — •Helmut Rathgen — 3. Physikalisches Institut, Uni Stuttgart

Possible dielectric optical grating designs for a chirped pulse amplification scheme are investigated through numerical simulations, with focus on large spectral bandwidth. Grating geometries are considered (i) in transmission, (ii) buried grating between two glass bodies, (iii) TIR grating geometry. The effect of a high refractive index grating layer (n=2–4) is studied. An increase of the spectral bandwidth is observed. The -0.5dB bandwidth around the design wavelength is shown to increase by 1.5–3x (as compared to a fused silica grating). The short wavelength efficiency is found to exceed -3dB. Grating designs that provide a flat -1dB bandwidth over one octave are suggested.

Q 14.2 Mo 16:45 VMP 8 R206

Neuartige Transmissionsgitterkonzepte mit verminderten Reflexionsverlusten — •Tina Clausnitzer[1], Marcel Schulze[1], Ernst- Bernhard Kley[1] und Andreas Tünnermann[1,2] — [1]Institut für Angewandte Physik, Friedrich-Schiller Universität Jena — [2]Fraunhofer Institut für Angewandte Optik und Feinmechanik Jena

Dielektrische Beugungsgitter haben in den letzten Jahren, in verschiedensten Anwendungsgebieten, weit über die klassische Spektroskopie hinaus, Verbreitung gefunden. Vor allem in Ultrakurzpulslasersystemen bilden Sie wichtige Schlüsselkomponenten, die leistungslimitierend für den gesamten Aufbau sein können. Neben dielektrischen Reflexionsgittern, welche ähnlich zu klassischen metallischen Gittern eingesetzt werden, stieg in den letzten Jahren zunehmend die Nachfrage nach Transmissionsgittern, die sehr hohen Laserleistungen standhalten und Beugungseffizienzen bis nahe 100% aufweisen können. Ein wichtiger Aspekt bei der Optimierung von Transmissionsgittern ist die Minimierung störender Reflexionsverluste, welche insbesondere bei der Forderung nach hoher Dispersion zu einer beträchtlichen Verminderung der Effizienz führen können. Obwohl solche Gitter Strukturabmessungen im Submikrometerbereich besitzen und darum klassische Antireflexbeschichtungen nicht mehr anwendbar sind, gibt es doch verschiedene Ansätze zur Unterdrückung der Reflexion, welche hier vorgestellt werden. Neben der anschaulichen Erklärung der Konzepte werden auch theoretische Designs und experimentelle Ergebnisse diskutiert, die die reproduzierbare Realisierung von hocheffizienten hochdispersiven Gittern versprechen, die höchsten Laserleistungen standhalten.

Q 14.3 Mo 17:00 VMP 8 R206

All-fiber control of the repetition rate of an erbium fiber laser — Markus Löser[1,2], •Till Walbaum[1], Petra Gross[1], and Carsten Fallnich[1] — [1]Institut für Angewandte Physik, Westfälische Wilhelm-Universität Münster, Münster, Deutschland — [2]Westsächsische Hochschule Zwickau (FH), Fachbereich Physikalische Technik, PF 201037, Zwickau, Deutschland

Stabilization of the repetition frequency of mode-locked lasers is an important issue for synchronisation purposes. Fiber optical means are of special interest in this context due to their low cost and high environmental stability. In order to realize an all-fiber control of the repetition rate, we have developed a fiber stretcher based on low-bending loss single mode fiber. Our device is capable of changing the repetition rate of an erbium fiber laser by more than 1.1kHz at a fundamental frequency of 47.66MHz, which is to our knowledge the largest difference yet achieved by fiber stretching. With this novel stretcher, repetition rate stabilization has been established, fully neutralizing thermal drift. Frequency noise could be reduced to 57mHz RMS, limited by the available RF-reference. Stress-induced changes of polarization have been charaterized and were shown to be negligible. While being stabilized, the pulse repetition rate could still be tuned within several hundred Hertz without affecting pulse duration or optical spectrum significantly, while the output power remained constant within ±2% and the pulse duration within ±2fs over the whole tuning range. The work will be continued including investigations for the transfer of repetition rate stability to a second laser by optical means only.

Q 14.4 Mo 17:15 VMP 8 R206

A chirped photonic crystal fiber for high-fidelity guiding of sub-100 fs pluses — •J. Bethge[1], M. Bock[1], D. Fischer[1], J. S. Skibina[2], V. I. Beloglasov[2], S. Burger[3], R. Iliew[4], and G. Steinmeyer[1] — [1]Max Born Institute, Berlin — [2]Saratov State University, Saratov (Russia) — [3]Konrad Zuse Institute, Berlin — [4]Friedrich-Schiller-Universität, Jena

Photonic crystal fibers usually confine the light by means of a periodic cladding, consisting of several layers of identical cells [1]. This design resonantly decreases the transmission losses of such fibers to values of a few dB/km in a narrow wavelength range. However, the rather narrowband transmission bands and the detrimental third order dispersion characteristics of this single-cell design generally render application of such hollow-core fibers difficult in the femtosecond range. Therefore, no fiber-based concept can currently provide guiding of sub-100 fs pulses over extended distances. By introducing a radial chirp into the photonic crystal [2] we here demonstrate a novel concept for photonic crystal fibers that breaks with the paradigm of lattice homogeneity and enables a new degree of freedom in photonic crystal fiber design, eliminating much of the pulse duration restriction of earlier approaches. We demonstrate that the small GVD of chirped photonic crystal fibers allows for surprisingly weak stretching of 13 fs pulses, which only double their duration within 1 m of guided propagation.

[1] P. Russell, Science **299**, 358-362 (2003)
[2] J. Skibina, Nature Phot. **2**, 679-683 (2008)

Q 14.5 Mo 17:30 VMP 8 R206

Optical Parametric Amplification in the NIR in a gaseous medium by use of a hollow fibre — •Alexander Grün[1], Daniele Faccio[1,3], Arnaud Couairon[4], Philip K. Bates[1], Olivier Chalus[1], and Jens Biegert[1,2] — [1]ICFO-Institut de Cienciès Fotóniques, Mediterranean Technology Park, 08860 Castelldefels (Barcelona), Spain — [2]ICREA-Institució Catalana de Recerca i Estudis Avançats, 08010 Barcelona, Spain — [3]CNISM-Dipartimento di Fisica e Matematica, Università dell'Insubria, IT-22100 Como, Italy — [4]CNRS-Centre de Physique Théorique, École Polytechnique, F-91128, Palaiseau, France

Nonlinear optical interactions in gas-filled hollow fibres are currently widely employed for the generation of intense, few-cycle laser pulses, playing a particularly important role in strong field physics applications such as attosecond pulse generation. Shifting the center wavelength of such few-cycle pulses toward the MIR is of great importance for the generation of shorter attosecond pulses, and allow improved efficiency in extreme ultraviolet (EUV) generation.

Here we report for the first time, to the best of our knowledge, efficient optical parametric amplification (OPA) of ultrashort intense laser pulses in a gaseous medium in the near infrared (NIR). By properly exciting the modes of the capillary and by further optimization of the gas pressure we show broadband phase-matched OPA with a gain exceeding 30 dB at the input seed wavelength of 400 nm and generation of high energy 4 μJ NIR pulses that are also expected to be passively carrier-envelope phase (CEP) locked.

Q 14.6 Mo 17:45 VMP 8 R206

Infrared generation beyond BBO: easy tuning from 850 nm to above 5 μm with novel optical parametric amplifiers — •Maximilian Bradler, Christian Homann, Markus Breuer, and Eberhard Riedle — LS für BioMolekulare Optik, LMU München

Ultrashort few-cycle pulses in the Mid-Infrared (MIR) are interesting for many applications such as time-resolved vibrational spectroscopy or high-field science. The most common approach to produce tunable MIR pulses is difference frequency mixing, e.g. of the signal and idler of an optical parametric amplifier (OPA). However, this renders a relatively narrow bandwidth, pulse lengths not much below 100 fs and low overall conversion efficiency in the 1 % range. Here we present a hybrid approach that yields ultrashort carrier-envelope-phase stable MIR pulses up to 5 μm directly as the output of an OPA. We first preamplify selected parts of a white-light supercontinuum generated in yttrium aluminum garnet (YAG) in BBO. As pump we use the second harmonic of a Ti:Sa regenerative amplifier for tunability in the wavelength range between 850 nm and 1550 nm. In a second stage we further amplify these pulses in a LiNbO3 crystal pumped by the 775 nm fundamental output of the Ti:Sa laser. This directly renders idler pulses in the desired wavelength range from 1550 nm to about 5.3 μm.

With 240 μJ total pump energy we achieve pulse energies of more than 5 μJ up to 4 μm corresponding to an overall efficiency of more than 8% over a wide tuning range. The transform limit of the pulse widths is as low as 25 fs. An autocorrelation measurement confirms a pulse width of 42 fs at 3.8 μm, equivalent to just 3.5 optical cycles.

Q 14.7 Mo 18:00 VMP 8 R206

Micro-Joule energy, mid-IR pulses with 9-cycle duration from a 100 kHz OPCPA source — •Alexander Grün[1], Olivier Chalus[1], Philip K. Bates[1], Mathias Smolarski[1], and Jens Biegert[1,2] — [1]ICFO-Institut de Cienciès Fotóniques, Mediterranean Technology Park, 08860 Castelldefels (Barcelona), Spain — [2]ICREA-Institució Catalana de Recerca i Estudis Avançats, 08010 Barcelona, Spain

Ultrashort pulsed light sources in the mid-IR are sought for numerous different fields, e.g. strong field physics, which demands high repetition-rate few-cycle pulses with stable carrier envelope phase (CEP). Generating such pulses in the mid-IR should result in shorter attosecond pulses, while broad bandwidth mid-IR pulses also cover many vibrational transitions in important molecules, opening a wide range of spectroscopic applications, e.g. medical breath monitoring.

Here we present such a completely new, scalable and potentially CEP stable source based on OPCPA, generating 9 cycle pulses at 3.2 μm with 1.2 μJ energy at a repetition rate of 100 kHz.

Q 14.8 Mo 18:15 VMP 8 R206

Generation of 8 fs, 125 mJ Pulses by use of Optical Parametric Chirped Pulse Amplification — Daniel Herrmann[1], Laszlo Veisz[1], Raphael Tautz[1], Franz Tavella[2], Karl Schmid[1,3], Alexander Buck[1], Vladimir Pervak[3], Michael Scharrer[4], Philip Russell[4], and •Ferenc Krausz[1,3] — [1]Max-Planck Institut für Quantenoptik, Garching, Deutschland — [2]HASYLAB/DESY, Hamburg, Germany — [3]Department für Physik Ludwigs-Maximilian-Universität München, Garching — [4]Max-Planck Forschungsgruppe Institut für Optik, Information und Photonik, Universität Erlangen-Nürnberg, Erlangen, Deutschland

We report generation of three-cycle, 8 fs, 125 mJ optical pulses in a noncollinear optical parametric chirped-pulse amplifier (NOPCPA). These 16 TW laser pulses are compressed to within 6% of their Fourier limit. Our system starts with a broad-bandwidth frontend with improved hollow-core fiber, which delivers seed pulses with an energy of 0.4 mJ at 1 kHz repetition rate. It is optically synchronized with a Nd:YAG laser, which provides 532 nm pump pulses of 1.2 J energy and 80 ps duration at 10 Hz repetition rate. We use a negative-dispersive grism pair and an acousto-optic modulator to stretch the seed pulse to 30 ps with 3 microjoules energy for seeding the single-pass two-stage NOPCPA. After amplification, the signal energy is 150 mJ. Subsequently, the amplified signal pulse is compressed by use of glass bulks and chirped mirrors, and is characterized by using a home-built autocorrelator and a FROG device. This laser system permits exploring attosecond and high-field physics in a so far inaccessible regime.

Q 14.9 Mo 18:30 VMP 8 R206

Modeling Non-collinear Optical Parametric Chirped-Pulse Amplification — •Jiaan Zheng and Helmut Zacharias — Physikalisches Institut, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Str.10, 48149 Münster, Germany

Due to the extremely broad spectral acceptance bandwidth non-collinear optical parametric chirped-pulse amplification (NOPCPA) is a promising technique to generate intense pulses with few-cycle pulse duration [1]. In this talk, a new model to describe the parametric process of three-wave interaction in the non-collinear optical parametric chirped-pulse amplification (NOPCPA) is presented, in which the effects from the non-collinear configuration have been taken into account. By utilizing this new model, a two-stage NOPCA system based on BBO with type I phase matching is numerically calculated with a split-step Fourier transform algorithm. Tracing the dynamic process of pump, signal and idler in the crystal reveals that in the beginning stage gain narrowing occurs due to the weak input signal intensity and the non-uniform temporal distribution of the pump light. However, in the saturation regime the spectrum of the signal will be broadened as a consequence of the back conversion process. The simulation shows that it is crucial to correctly control the experimental parameters to balance both processes. [1] F. Tavella, Y. Nomura, L. Veisz, V. Pervak, A. Marcinkevičius and F. Krausz, Opt. Lett. 32, 2227 (2007)