Q 37: Ultrashort Laser Pulses

Time: Wednesday 14:00–15:45 Location: f435

Q 37.1 Wed 14:00 f435

Millisecond wavelength tuning across hundreds of nanometers of a fiber optical parametric oscillator — •Tim Hellwig[1,2], Maximilian Brinkmann[1,2], and Carsten Fallnich[1] — [1]Institute of Applied Physics, University of Münster, Germany — [2]Refined Laser Systems GmbH, Münster, Germany

We present a mechanical delay-free tuning concept for optical parametric oscillators (OPO) removing the main barrier for high-speed switching between arbitrary wavelengths. The concept is based on dispersive matching of the repetition frequency change occurring during wavelength tuning of a pump laser to the associated change of repetition frequency in the OPO. We present a fiber-based optical parametric oscillator (FOPO), which is all electronically tunable within 5 ms. The FOPO was built from all-spliced components and the parametric gain was supplied by 50 cm of photonic-crystal fiber. The signal was all-electronically tunable from 780 to 970 nm with the corresponding idler wavelengths of 1150 to 1500 nm. For a conventional OPO this change in wavelength would be associated with a necessary mechanical delay of about 2 cm leading to the typical tuning times of at least several seconds. A second output provided access to 500 mW of pump pulse power usable for pump and probe experiments. With output powers of up to 200 mW for the signal wave, matching pulse durations of all outputs of 7 ps at 40 MHz and with excitation bandwidths of <12 cm-1 the presented system shows ideal performance, e.g., for efficient coherent Raman imaging.

Q 37.2 Wed 14:15 f435

Nonlinear Pulse Compression in a Dispersion-Alternating Fiber — •Niklas M. Lüpken[1] and Carsten Fallnich[1,2] — [1]Institute of Applied Physics, University of Münster, Corrensstraße 2, 48149 Münster, Germany — [2]MESA+ Institute for Nanotechnology, University of Twente, Enschede 7500 AE, The Netherlands

Based on the concept of alternating dispersion [1] we show improvements for nonlinearly compressing light pulses down to the few-cycle regime in a fiber chain with alternating dispersion.

Whereas the normally dispersive fiber segments generate bandwidth via self-phase modulation, the anomalously dispersive fiber segments recompress the broadened spectral bandwidth by an appropriate amount of group velocity dispersion. This approach avoids the use of free-space pulse compressors, the need for high pulse energies, or the precise control of the fiber length, whereas all these issues do represent drawbacks of current schemes. For shorter pulses, further pairs of fiber segments can be added with taking a trade-off between resulting peak power and unavoidable splicing losses into account.

In first experiments, nearly bandwidth-limited 25 fs pulses at 1560 nm were achieved from 80 fs input pulses, giving a pulse compression factor of 3.2. The use of a special anomalous dispersive fiber eliminated the impact of higher-order dispersion, such that a high spectral coherence was ensured. The results were in good agreement with nonlinear Schrödinger equation simulations, which also predicted that the concept is transferable to longer input pulses.

[1] Inoue et al., J. Light. Technol. 24, 2510 (2006).

Q 37.3 Wed 14:30 f435

Polarization gauge for few-cycle high intensity laser pulses — •Marius te Poel, Michael Stumpf, Julian Wegner, and Georg Pretzler — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf

We present a gauge which allows for precise measurements of the polarization in lasers with ultrashort pulses and high power. Standard polarizers either tend to bleach out or are not selective enough in the required near-infrared range, and most of all, many of the employed effects are too wavelength-sensitive concerning the broad spectra of ultrashort pulse lasers. We present a new type of broadband polarization gauge which is based on Brewster-angle reflection at a fused silica mirror. This effect turns out to be almost constant over a bandwidth from 600 to 1000 nm. The device can be tuned to different wavelength ranges by adjusting the reflection angle and was used for detecting the exact direction of linearly polarization as well as the main axis of elliptically polarized light. We present the setup and characterization data of the PHASER sub-10-fs Ti:Sa-laser system in Düsseldorf. Furthermore, we discuss and present applications of the device.

Q 37.4 Wed 14:45 f435

A dispersion-free Attenuator for Ultra-short Laser Pulses — •Julia Kunzelmann, Julian Wegner, and Georg Pretzler — Institut für Laser- und Plasmaphysik, Heinrich Heine Universität Düsseldorf

Lasers play an important role in technology and science. For many applications, the power and intensity must be accurately adjusted. With few-cycle laser pulses, a main challenge consists in varying the laser pulse intensity without changing any other parameter, like the temporal pulse shape or the focus spot size. We developed a new fully reflective pulse attenuator which is based upon properly shaped thin metal layers. This decreases the pulse energy by several orders of magnitude in many fine steps while keeping the other parameters constant.

We present the setup of our device together with simulations of the reflective layers and various measurements which show that other parameters are not affected. Furthermore, a few examples are given in which the new attenuator has been applied fruitfully in laser-matter interaction experiments.

Q 37.5 Wed 15:00 f435

Common pulse retrieval algorithm: a universal and accurate method to retrieve ultrashort pulses — •Nils C. Geib[1], Heiko Knopf[1,2], Gia Quyet Ngo[1], Thomas Pertsch[1,2], and Falk Eilenberger[1,2] — [1]Institute of Applied Physics, Abbe Center of Photonics, Friedrich Schiller University, Albert-Einstein-Str. 15, 07745 Jena, Germany — [2]Fraunhofer Institute for Applied Optics and Precision Engineering IOF, Center for Excellence in Photonics, Albert-Einstein-Str. 7, 07745 Jena, Germany

Many ultrashort laser pulse measurement schemes such as frequency-resolved optical gating (FROG), interferometric FROG, dispersion scan, or time-domain ptychography require a specific, iterative algorithm to retrieve pulse amplitude and phase from the measurement. In this work, we present a common pulse retrieval algorithm (COPRA) that can be applied on a broad class of measurements, including but not limited to the aforementioned ones. It can also be universally applied to measurements for which no specific retrieval algorithm was known before. We test our approach on numerical and experimental data and show that it is reliable and accurate in the presence of Gaussian measurement noise. Furthermore, we discuss how to obtain reliable uncertainty estimates on the retrieved pulses.

Q 37.6 Wed 15:15 f435

Spontaneous Four-Wave Mixing Light Source in Silicon Nitride Waveguide for Coherent Raman Scattering — •Niklas M. Lüpken[1], Thomas Würthwein[1], Klaus-J. Boller[2,1], and Carsten Fallnich[1,2] — [1]Institute of Applied Physics, University of Münster, Corrensstraße 2, 48149 Münster, Germany — [2]MESA+ Institute for Nanotechnology, University of Twente, Enschede 7500 AE, The Netherlands

Silicon nitride (Si_3N_4) waveguides offer an on-chip platform with a small footprint, a high nonlinear refractive index, and tight mode confinement. Therefore, nonlinear processes such as four-wave mixing (FWM) or supercontinuum generation can be driven very efficiently, e.g., for broadband optical frequency combs [1].

Within this contribution, we present a light source for coherent anti-Stokes Raman scattering (CARS) microscopy, with the potential to be set up as an all-integrated device, based on spontaneous FWM in Si_3N_4 waveguides with only a single ultrafast fiber-based pump source at 1030 nm wavelength. During the FWM process in the Si_3N_4 waveguide, broadband signal and idler pulses are generated, such that the idler pulses and the residual pump pulses can be used for CARS measurements, enabling chemically selective and label-free imaging over the entire fingerprint region by addressing vibrational energies from $500\,\mathrm{cm}^{-1}$ to $1800\,\mathrm{cm}^{-1}$.

[1] Porcel et al., Opt. Express 25, 1542 (2017).

Q 37.7 Wed 15:30 f435

Triggering Dispersive Waves via XPM in Si_3N_4 Integrated Optical Waveguides — •Maximilian Timmerkamp[1], Niklas M. Lüpken[1], and Carsten Fallnich[1,2] — [1]Institute of Applied Physics, University of Münster, Corrensstraße 2, 48149 Münster, Germany —

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Supercontinua are of high interest in current research due to their broad bandwidth and high brightness enabling a manifold of applications in, e.g., spectroscopy or precision metrology.

Typically, a higher-order soliton is formed during the supercontinuum generation process, which is perturbed by higher-order dispersion leading to the fission into fundamental solitons, each radiating energy into a dispersive wave [1]. These dispersive waves propagate in the same transverse mode as the corresponding solitons.

In multi-mode waveguides, nonlinear coupling allows for energy exchange between transverse modes. In this contribution, we show an experimental evidence of soliton dynamics in multi-mode silicon nitride (Si_3N_4) waveguides, where a dispersive wave is generated in a different transverse mode than the pump mode, triggered by intermodal cross-phase modulation. These intermodal soliton dynamics lead to new phase-matching conditions, enabling the generation of new frequencies.

[1] Roy et al., Phys. Rev. A 79, 023824 (2009)