Generation of high-order harmonics with ultra-short pulses from filamentation

E. Schulz[*,†1], **D. S. Steingrube**[*,†2], **T. Vockerodt**[*,†], **U.Morgner**[*,†,‡], **and M. Kovačev**[*,†]

[*]Institut für Quantenoptik, Leibniz Universität Hannover, Welfengarten 1, D-30167 Hannover, Germany
[†]QUEST, Centre for Quantum Egineering and Space-Time Research, Hannover, Germany
[‡]Laser Zentrum Hannover e.V., Hollerithallee 8, D-30419 Hannover, Germany

Synopsis We obtain 7-fs-pulses with 0.3 mJ after filamentation and pulse compression by double-chirped-mirrors (DCM). We use these pulses to generate high-order harmonics in a semi-infinite gas cell setup. Spectral broadening of the harmonics in different gases is observed. Especially in neon an extended continuous cut-off region down to 10 nm (124 eV) can be realized. This opens up the way to attosecond-pulse generation from filamented pulses.

We present high-order harmonic generation (HHG) in a semi-infinite gas cell from filamented pulses. The 30-fs-pulses from a CPA-laser-system with pulse energy of 1.2 mJ, a repetition rate of 3 kHz and a central wavelength of 776 nm are spectrally broadened in a filament and compressed down to 7 fs.

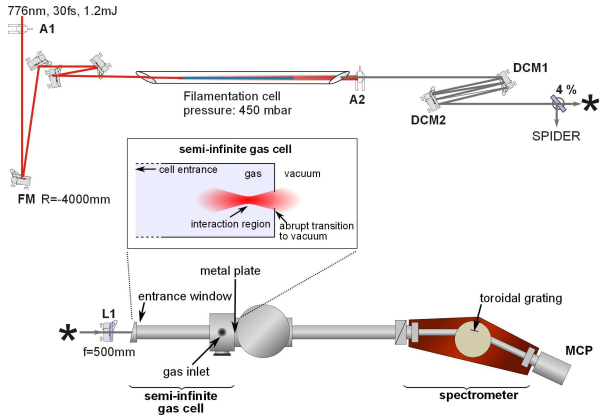

Fig. 1. Sketch of filamentation and HHG setup. The CPA-pulses are compressed in a filament setup and the harmonics are generated in a semi-infinite gas cell. The entrance window of the cell is far from the interaction region. A pinhole ensures an abrupt transition to vacuum for absorption-less propagation.

For filamentation we focus the beam into a gas cell filled with argon and select only the center of the beam profile that contains the octave spanning spectrum from 400 nm to 900 nm. A pulse energy of 0.3 mJ can be used to generate the high-order harmonics in a semi-infinite gas cell setup [1] [2] as shown in figure 1.

We generate high-order harmonics in different noble gases. The broadening of the harmonic spectra is measured for argon, xenon, and neon. The broadest continuum and the highest cut-off energy is observed in neon, see figure 2, which is the gas with the highest ionization energy of the investigated rare gases.

Singe attosecond pulses via few-cycle pulses from filamentation are now in reach. Due to the energy scaling properties of the filamentation process higher photon and pulse energies in isolated attosecond pulses become feasible.

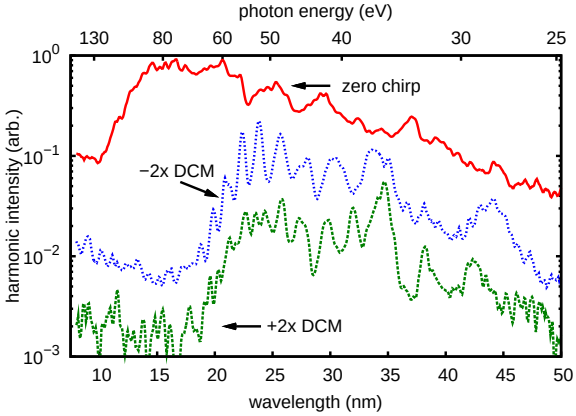

Fig. 2. Harmonic spectra in 40 mbar neon and the effect of dispersion on the cut-off energy. The spectra for positively (+2x DCM), negatively (-2x DCM) chirped and compressed pulses (zero chirp) are shown.

References

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[1]E-mail: schulz@iqo.uni-hannover.de
[2]E-mail: steingrube@iqo.uni-hannover.de