High-repetition rate attosecond pulse source for coincidence spectroscopy

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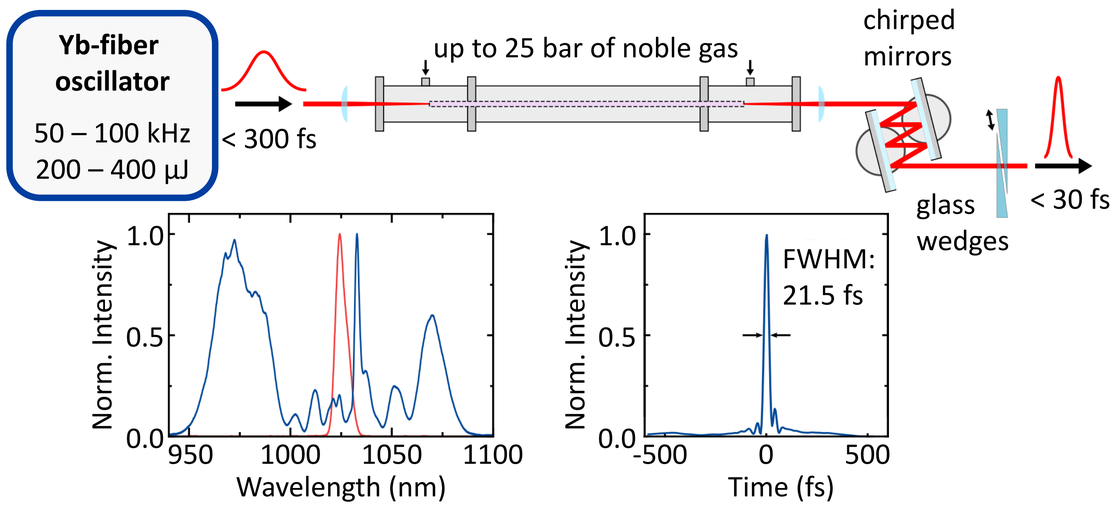
Abstract

Coherent extreme ultraviolet (XUV) attosecond laser pulses provide excellent temporal and spatial resolution and are therefore in great demand for numerous applications in science, allowing us to study ultrafast dynamics in atoms, molecules, solids and even in more complex physical systems[1]. The nonlinear process of high-order harmonic generation (HHG), driven by ultrashort and few-cycle visible (VIS) or infrared (IR) pulses, offers an elegant approach to achieve table-top sources of such radiation[2]. It has turned out that especially for many spectroscopy experiments a high repetition rate is required in order to provide better statistics. Here, we present an attosecond pulse source working between 50 and 100 kHz which we are currently developing for photoelectron/-ion coincidence spectroscopy.

Nonlinear pulse compression (NPC)[3,4]

Spectral broadening via self-phase modulation

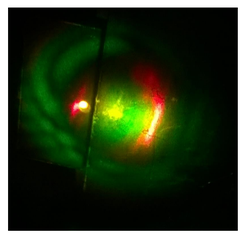
→ Temporal compression using multiple reflections on highly dispersive and broadband chirped mirrors

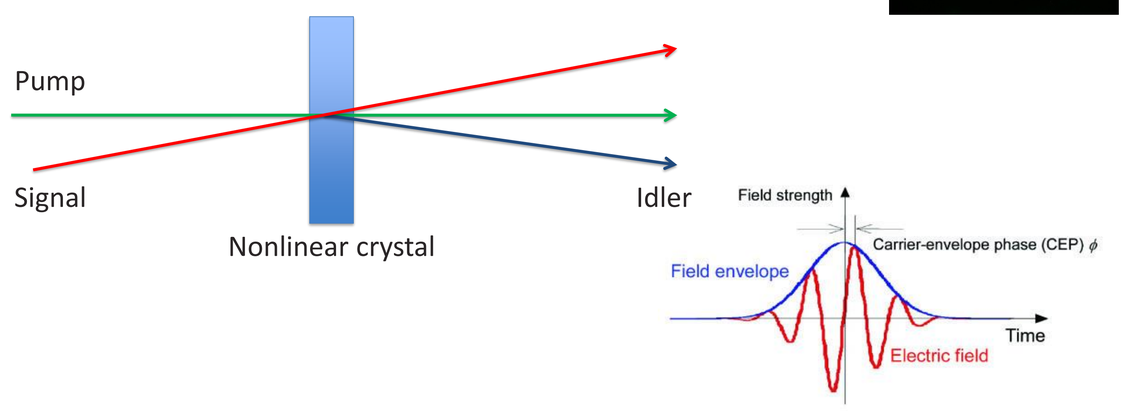


Optical parametric chirped pulse amplification (OPCPA)[5,6]

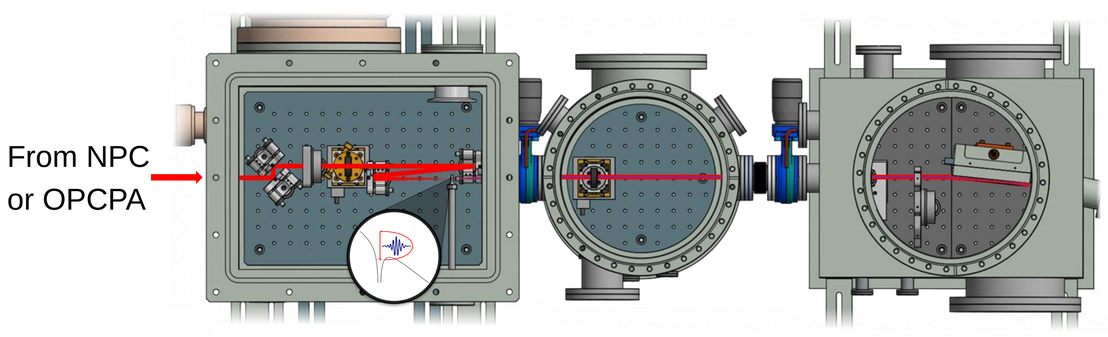
Generation of few cycle IR pulses with passively stabilized Carrier Envelope Phase

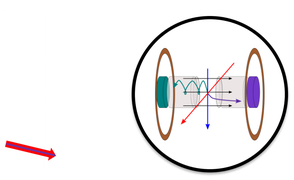
→ Idler generation and amplification through Difference Frequency Generation and Optical Parametric Amplification

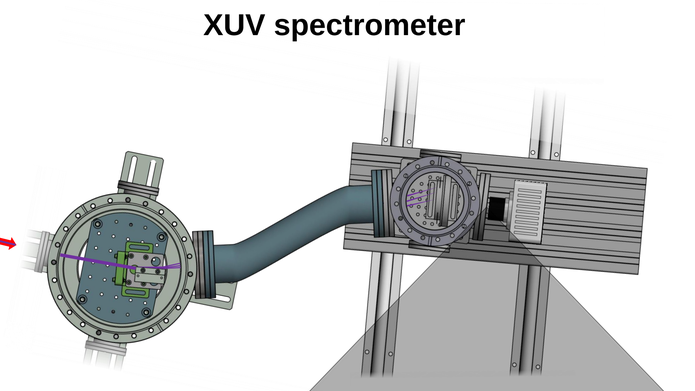




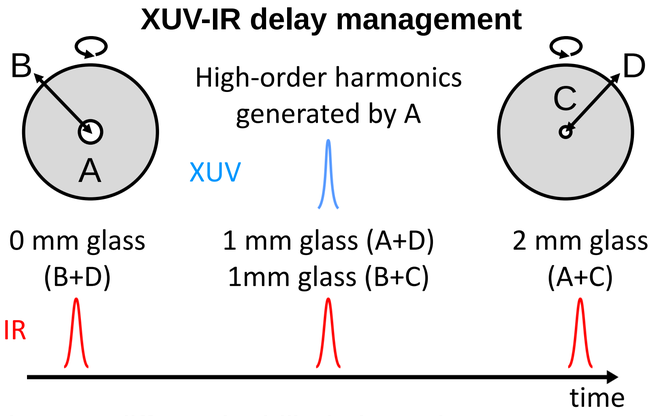
Attosecond beamline & photoion/photoelectron coincidence spectroscopy







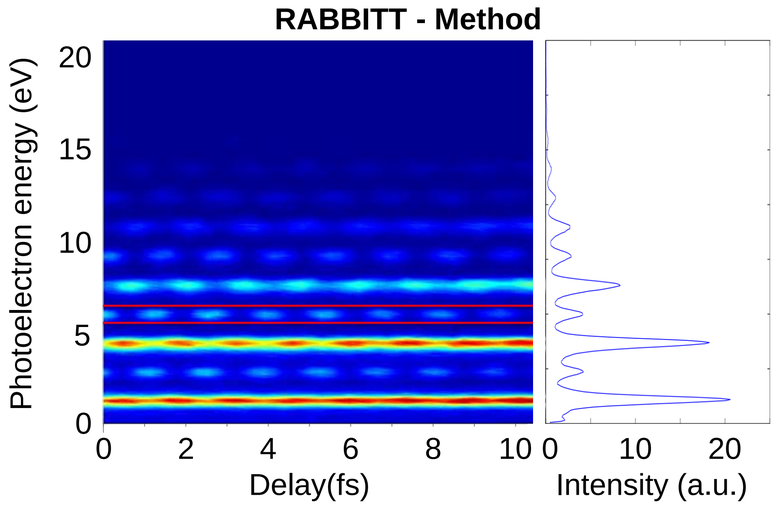
XUV-IR delay management

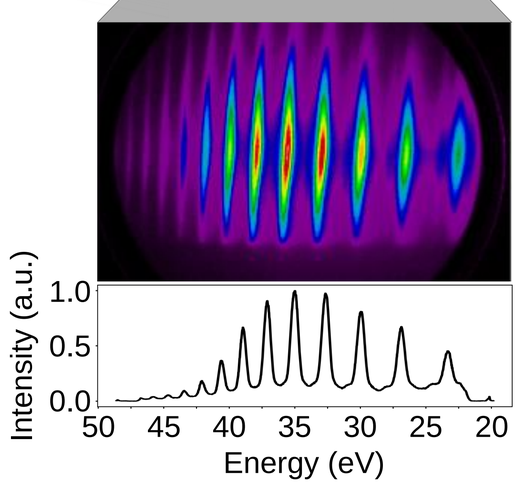


Using two differently drilled glass plates:

- XUV generated by the annular part of the IR beam
- Rotation of 2nd plate
  → delay control with attosecond precision

RABBITT - Method





Future work

- Coincidence spectroscopy of (cold) atoms and highly symmetric molecules such as CF_4, CH_4 and SF_6
  → Most complete picture of internal mechanism of energy conversion after initial photoionization or photoexcitation event
- Generation of isolated attosecond pulses via polarization gating method

…and more!!!

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References & Acknowledgements

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