Program of the workshop

September 18th 2015

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Future Of Ultrashort Pulses
Website: http://www.future-of-ultrashort-pulses.de/
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9:00- 9:05	**introductory remarks**

Session 1	**Chairman: Dr. Oleg Pronin**
9:05-9:40	**Dr. Thomas Metzger** **TSL GmbH, Munich, Germany**

Title: Ultrafast Thin-Disk Lasers

Abstract: Since its first demonstration in 1994, thin-disk lasers have been one of the most promising concepts for scaling sub-picosecond pulses to highest peak and average powers. TRUMPF Scientific Lasers uses the industrial thin-disk laser technology for developing ultrafast amplifiers with highest average powers and pulse energies. The presentation will give an introduction to the TRUMPF group, picosecond thin-disk lasers and their use for pumping optical parametric amplifiers.

9:40-10:15	**Dr. Oliver Muecke** **CFEL, Hamburg, Germany**

Title: High-Energy Sub-Cycle Parametric Waveform Synthesis

Abstract: A first incarnation of a 3-channel, multi-mJ, sub-cycle, parametric waveform synthesizer driven by a Ti:sapphire CPA will be presented. This system can be regarded as a prototype parametric synthesizer architecture that at the moment is directly transferred to cryo-cooled Yb pump-laser technology to overcome pulse-energy and average-power bottlenecks for advanced applications. Such intense optical waveforms $E(t)$ custom-sculpted within an optical cycle open up new horizons for controlling strong-field interactions in atoms, molecules, solids and nanostructures, for attosecond pump-probe spectroscopy employing ultrashort pulses from the THz to the X-ray regions, and for the generation of intense isolated attosecond XUV pulses for XUV-pump/XUV-probe spectroscopy.

10:15-10:45	**coffee break**

Session 2	Chairman: Dr. Martin Schultze
10:45-11:20	Prof. Jens Biegert ICFO, Barcelona, Spain

Title: Ultrafast mid-IR sources and their impact to attoscience

Abstract: Electron recollision in an intense laser field is at the centre of attoscience research and gives rise to a variety of phenomena, ranging from the photo effect to coherent X-ray emission. We have, over the years, developed intense sources of waveform controlled mid-IR light, i.e. few-cycle duration and carrier to envelope phase stable pulses, to exploit ponderomotive scaling, quantum diffusion and quasi-static photo emission. I will describe the laser technology that enables this new direction of strong field research and our recent achievements in the generation of attosecond pulses at the oxygen K-shell edge (530 eV) and application to soft X-ray absorption spectroscopy in condensed matter.

11:20-11:55	Dr. Caterina Vozzi Institute for Photonics and Nanotechnologies, Milan, Italy

Title: High-order harmonics driven by high-energy Optical Parametric Amplifier: a promising tool for ultrafast molecular imaging

Abstract: High-order harmonic generation (HHG) has been demonstrated to be a powerful table-top tool for temporal resolved measurements in the XUV spectral region with resolution ranging from the femtosecond to the attosecond domain. Big steps forward have been recently demonstrated in increasing the harmonic pulse intensity as well as in extending the available spectral bandwidth. Since harmonic cut-off frequency scales as the square of the driving carrier wavelength, laser sources operating in the IR have been used as a way to extend the harmonic emission spectrum up to keV energies. The main drawback of this approach is the reduction of the harmonic yield expected with increasing driving wavelength.

We present experimental results on HHG spectroscopy driven by a few-cycle high-energy parametric source in the IR (1.4-1.6 micron). These results demonstrate the possibility to exploit the high harmonic imaging technique for atoms and molecules in energy regions which were previously not accessible and to extend this method to systems with low ionization potential.

12:00-13:30	lunch break

Session 3	Chairman: Dr. Ioachim Pupeza
13:30-14:05	Dr. Hanieh Fattahi MPQ, Munich, Germany

Title: High power multi-terawatt Field Synthesizer

Abstract: A complete picture of electrodynamics in solids, with the subatomic resolution in space and time, is possible by combining x-ray diffraction and attosecond spectroscopy. This technique requires angstrom-wavelength isolated attosecond pulses. Therefore its realizability is the question of availability of a source which could push the frontiers of high-harmonic generation (HHG) and attosecond pulse generation into keV photon energies and hard x-ray regime. Combining the concept of short-pulse pumped OPCPA with waveform transients holds promise to revolutionize the current state of the art of HHG and enables us to extend the HHG cutoff energy to keV x-ray pulses. In this talk the current state of the art of a multi-terawatt field synthesizer under development for this purpose, will be discussed.

14:05-14:40	Prof. John Tisch, Blackett Laboratory, Imperial college, London, Britain

Title: Synchronized attosecond pulses in the VUV and XUV and other developments at Imperial College London

Abstract: This talk will describe our recent efforts to develop new attosecond and ultrafast light sources, including attosecond pulses in the challenging VUV range, spectrally isolated attosecond pulses from resonantly enhanced high harmonic generation (HHG) in plasma plumes, and enhanced HHG driven by sculpted waveforms formed by multi-colour field synthesis. As a step towards the characterisation of such complex optical waveforms that does not rely on the technical challenging attosecond streaking method, we have demonstrated an all-optical technique using HHG, which will be described. Finally, an attosecond streaking measurement of photoelectrons from non-crystalline surfaces will be presented.

14:40-15:00	coffee break

Session 4	Chairman: Dr. Nicholas Karpowicz
15:00-15:35	Dr. Eleftherios Goulielmakis MPQ, Munich, Germany

Title: Attosecond Optical Synthesis and Electronics

Abstract: With the fastest optical and soft x-ray fields as a part of its repertoire, attosecond physics has opened up new avenues for exploring ultrafast electronic processes in atoms, molecules, surfaces or nanostructures. I will discuss how attosecond optical synthesis of light allows, the exploration and control of fundamental electronic phenomena in condensed matter. Electron motion in bulk media, driven by intense, precisely-sculpted, optical fields gives rise to controllable electric currents, the frequency of which extends to the multi-ten-Petahertz range, advancing lightwave electronics to new realms of speed and precision. Coherent extreme ultraviolet radiation emerging in these coherent charge oscillations offers direct insight into structural and dynamical properties of the underlying medium, previously inaccessible to conventional solid-state spectroscopies. By endowing essential x-ray spectroscopies of solids with attosecond temporal resolution, optical half-optical cycle fields, combined with extreme ultraviolet pulses, offer, for the first time, access into the attosecond dephasing of electronic excitation of highly-correlated, condensed phase electronic systems. We anticipate these new capabilities to result in far reaching implications to fundamental and applied, electronic and photonic sciences.

15:35-16:10	Matthias Hohenleuthner University of Regensburg, Regensburg, Germany

Title: Sub-cycle high-harmonics from terahertz-driven crystal electrons

Abstract: Utilizing the carrier wave of intense, phase-locked light pulses to control electron motion in atoms and molecules has opened up spectacular new routes in ultrafast photonics such as high-harmonic generation (HHG) and attosecond physics. The recent discovery of HHG in solids combines the idea of ultrafast quantum control with complex condensed matter systems. We employ intense, phase-controlled waveforms in the multi-THz spectral range to drive ultrabroadband HHG in bulk semiconductors. Sub-cycle time- and field-resolution allows us to directly follow the terahertz-driven wavepacket dynamics with precise temporal correlation to the driving waveform. Intriguing features in the measured time structure of high-order

harmonics unravel a novel quantum interference of multiple interband excitation paths during high-harmonic generation. The direct time domain study of high-order harmonics from solids paves the way towards a full quantum picture of the underlying dynamics and sparks hope for next-generation solid-state sub-femtosecond sources.

16:10	**Prof. Ferenc Krausz** **MPQ, Munich, Germany**