LASERLAB Users Meeting Prague 2014

Abstracts of users talks

Monday September 29, 2014

Session 1 10:20

Petra Köster, Intense Laser Irradiation Laboratory, Instituto Nazionale di Ottica, Pisa, Italy

Title: Investigation of laser-target coupling in the intensity regime relevant to shock ignition (PALS)

Abstract: In the context of Inertial Confinement Fusion, Shock ignition is an appealing approach in the inertial confinement scenario for the ignition and burn of a pre-compressed fusion pellet. In this scheme, a strong converging shock is launched by laser irradiation at an intensity $I\lambda^2 > 10^{15}$ W cm^{-2} μm^2 at the end of the compression phase. In this intensity regime, laser–plasma interactions are characterized by the onset of a variety of instabilities, including stimulated Raman scattering, Brillouin scattering and the two plasmon decay, accompanied by the generation of a population of fast electrons. The laser-target coupling is investigated in a series of dedicated experiments at the Prague Asterix Laser Facility (PALS). We study the role of parametric instabilities in the extended plasma corona, the ability to create strong shocks and the role of fast electrons in a SI relevant regime in a planar geometry by creating an extended preformed plasma with a laser beam at ~7×10^{13} W cm^{-2} (250 ps, 1315 nm). A strong shock is launched by irradiation with a second laser beam at intensities in the range 10^{15} –10^{16} W cm^{-2} (250 ps) at various delays with respect to the first beam. The pre-plasma is characterized using x-ray spectroscopy, ion diagnostics and interferometry. Spectroscopy and calorimetry of the backscattered radiation is performed in the spectral range 250–850 nm, including (3/2)ω, ω and ω/2 emission. The fast electron production is characterized through spectroscopy and imaging of the Kα emission. Information on the shock pressure is obtained using shock breakout chronometry and measurements of the craters produced by the shock in a massive target. The main results of the experimental campaigns are presented and discussed in view of the Shock Ignition scheme

Session 2 11:15

VáclavKubeček, CTU in Prague, CR

Title: Fiber-seeded, 10-ps, 2050-nm, multi-mJ, cryogenic Ho:YLF CPA (ICFO)

Abstract: We demonstrate the first picosecond cryogenic Ho:YLF CPA system with Er:Tm:Ho fiber seeder. The system delivers energy-scalable 13-mJ pulses with 10-ps duration at 100 Hz repetition rate. (M. Hemmer, D. Sánchez, M. Jelínek, H. Jelínková, V. Kubeček, J. Biegert)

Session 2 11:35

Alberto Marocchino, Universita di Roma La Sapienza, Roma, Italy

Title: 13-TW-E3 magnetic field induction via Biermann battery effect for laboratory cluster blast wave (LULI)

Abstract: A recent experimental campaign performed on the ELFIE laser at LULI focused on reproducing laboratory Blast Wave relevant to astrophysical scenarios, e.g., with dimensionless parameters in accordance with astrophysical Supernova parameters. A 2J laser is focused into an Argon cluster gas to launch intense Blast Waves. The evolution is investigated from the early Coulomb explosion to late times. Electromagnetic fields are investigated via proton radiography. At early times an intense electric fields are measured, while the late time evolution seems to be purely hydrodynamic.

Session 2 11:55

Enda McGlynn, Dublin City University, Dublin, Ireland

Title: THG of ZnO nanorods for efficient third order interferometric FROG (MBI)

Abstract: ZnO nanorods grown by both high and low temperature deposition are promising sources for UV THG and show comparable efficiencies, much higher than surface THG at a bare quartz-air interface, in stark contrast to the vastly different linear optical properties of ZnO nanorods grown by these methods. The THG signal is analysed using intensity dependence and iFROG, to extract laser pulse parameters. The comparable levels of efficiency for UV THG of ZnO grown by these methods provide a broad suite of growth methods to suit various substrates, coverage and scalability requirements. Application areas range from characterization of few cycle fs pulses to single cell UV irradiation for biophysical studies.

Session 3 14:15

Brendan Dromey, Queens University Belfast, UK

Title: Polarisation gating of harmonic emission from relativistically oscillating plasmas (HIJ)

Abstract: High harmonic generation from intense laser solid density interactions has, over the last decade, demonstrated its clear potential as a next generation source of ultrafast, coherent X-rays. Observations of attosecond phase locking and diffraction limited performance have shown that the exceptional coherence properties of the intense driving laser ($>10^{20}$ Wcm^{-2}) can be transferred directly to the extreme ultraviolet (XUV) and X-ray regions of the spectrum with unprecedented

efficiency. To date this has been achieved via the formation of a relativistically oscillating mirror (ROM) at the critical density surface (up to 1000's of harmonic orders). Here we present progress towards gating the emission to provide a source of high power attosecond pulses. Furthermore, a novel method of implementing this technique for high power (≈>1J) laser pulses is presented along with proof of principle experimental results for ROM harmonics.

Session 3 14:35

Christopher Murphy, University of York, York, UK

Title: Inverse-Compton Scattering (ICS) from LWFA Electrons: A preview of the next intensity frontier (CLF)

Abstract: New laser facilities expect focused intensities >10^{23} W/cm^2. Theory predicts radiation reaction and QED effects greatly altering the plasma dynamics. Such fields are not yet accessible in the lab frame but are in the frame of a relativistic electron, giving insight into the physics available at future facilities. We present results using Astra-Gemini, demonstrating a gamma source from ICS in the very nonlinear regime. We show that this process contains physics relevant to laser-solid interactions at higher intensity. We outline theory supporting this campaign aimed at probing the effects which will radically change our understanding of future laser-plasma interactions.

Session 3 14:55

Seref Kalem, TUBITAK-BILGEM, Kocaeli, Turkey

Title: Photoluminescence dynamics in silicon quantum pillars (LLC)

Abstract: Excited state dynamics of carriers was investigated by time-resolved luminescence in Si quantum pillars. An ultrafast decay component of less than 10 ps and slower component of around 60 ps were deduced assuming a 3-component exponential decay as measured by streak camera. Ultrafast PL decay leads to a transfer of carriers to long-lived defect states as evidenced by a red emission at around 600 nm. Time-correlated single photon counting measurements revealed a life-time of about 5 ns. Results are discussed in terms of band structure modification and defects induced at surfaces involving dangling bonds and oxygen related defects nature of the emission is described and modeling is provided for the luminescence dynamics.

Session 3 15:15

Andrea Sgattoni, Politecnico di Milano, Milano, Italy

Title: Surface wave excitation on grating targets at SLIC

Abstract: Experimental and numerical results are presented for laser ion acceleration using solid Mylar "grating" target with a periodically structured surface on the irradiated side. The use of a double plasma mirror allowed a contrast ratio of 1×10^{12} so that the structures of the front surface withstood the pre-pulse. The "grating" target modulation had a regular modulation of 0.5 μm depth and 1.6 μm (2λ) period, corresponding to an angle of incidence θ = 30° for the resonant excitation of surface waves (SWs). For a target of 20 μm and changing θ between 15 to 45 degrees, a broad maximum in the proton energy cut-off E_{max} was observed around 30◦, with a peak value $E_{max} \approx 5$ MeV for a laser intensity of 1×10^{19} W/cm^2. In contrast, for flat targets no maximum was observed and $E_{max} \approx 2$ MeV at θ = 30°. This observation suggests that SWs are excited, for the first time in the relativistic regime, as also shown by numerical simulations. Experimental and simulation data show a strong increase of E_{max} with respect to flat targets also at small angles, and a collimated electron emission along the target surface has been seen, which could be also a signature of SW excitation. The experiment has been supported by the LaserLAB EU access scheme and the simulation campaign by the PRACE project "LSAIL".

Session 3 15:35

Florin Negoita, IFIN-HH, Bucharest-Magurele, Romania

Title: Gamma spectroscopy of short lived nuclear states produced by laser-driven high energy ion sources (LULI)

Abstract: In the presented experiment performed at ELFIE facility in LULI/Ecole Polytechnique (Palaiseau, France), protons accelerated through TNSA mechanism impinged a secondary target placed closely to the primary target. Population of several nuclear isomers with lifetimes down to few milliseconds has been measured through observation of specific gamma rays with a scintillation detector positioned at only about 10 cm from targets. The development of such in-situ gamma spectroscopy on short living nuclear states opens the possibility to perform shot-by-shot characterization of protons and heavy ions bunches at high repetition rates as well as new perspectives for studies of predicted modification of nuclear states lifetimes in hot plasma.

Session 3 15:55

Piotr Raczka, Institute of Plasma Physics and Laser Microfusion, Warsaw, Poland

Title: Recent results on laser-plasma interactions under conditions relevant for shock ignition (PALS)

Abstract: Experiments were performed to study the properties of plasma formed by a sequential action of two laser beams on a flat target, simulating the conditions of exposure to the shock-ignited ICF target. Planar targets consisting of a massive Cu plate coated with a thin CH layer were used, which were irradiated by the 1w PALS laser beam (λ=1.315 μm) at the energy of

250 J to create a preplasma. The main beam with a delay of 1.2 ns was then used to generate a shock wave in the massive part of the target. An array of diagnostics were used, including (i) a two channel polaro-interferometric system irradiated by the femtosecond laser with the pulse duration of ~ 40 fs; (ii) spectroscopic measurements in the X-ray range; (iii) spectroscopic measurements of the Kα line from Cu; (iv) measurements of ion emission by means of ion collectors; and (v) measurements of the volume of craters produced in massive targets providing information on efficiency of the laser energy transfer to the shock wave. The general conclusion is that the fraction of the main laser beam energy deposited into the massive part of the target decreases relative to the case of the target irradiation in absence of the pre-plasma.

Session 4 16:30

Xavier Mateos, University Rovira i Virgili, Tarragona, Spain

Title: Investigation of graphene as saturable absorber for mode-locking of solid-state bulk lasers (MBI)

Abstract: In the present project we developed carbon nanostructures (graphene and carbon nanotubes) as saturable absorbers (SA) to achieve short and ultrashort pulses in solid-state bulk lasers. The carbon nanostructures have been fabricated, characterized and tested as SA in laser cavities achieving laser pulses in several temporal regimes and at several laser wavelengths. Passively Q-switched Tm:KLuW crystal using single-layer graphene as SA operating at 1944 nm with a pulse duration of 1μs at a repetition rate of 35 kHz has been demonstrated. Shorter laser pulses at 2060 nm with a Ho,Tm:KLuW crystal also with graphene as SA have been achieved in the picosecond (ps) temporal regime, achieving 2.8 ps pulses at 91 MHz with an average output power of ~ 100 mW. Moving to 1 μm with Yb-CLNGG crystal and a single-walled carbon nanotube saturable absorber (SWCNT-SA), pulse durations as short as 90 fs are obtained at ~ 1049 nm. The maximum average output power is 90 mW at a repetition frequency of 83 MHz.

Session 4 16:50

Kamal Kaur, Centre for Microsystems Technology, Gent, Belgium

Title: Nano-LIFT assisted fabrication of SERS substrates (LP3)

Abstract: Raman spectroscopy is a powerful technique to identify the composition of a material by providing a fingerprint spectrum of the material under probe. However, it is an inherently weak process that requires either sensitive detection schemes and/or enhancement of signal strength. Surface enhanced Raman spectroscopy (SERS) is a technique that uses noble-metallic nanostructures to boost Raman signal by orders of magnitude and it is also an extremely sensitive technique. This enhancement significantly depends on the shape, size and gap between the metallic nanostructures. Nanosphere lithography (NSL) is one of best techniques to produce uniform SERS substrates with high enhancement factor. In this paper, we present a laser based direct printing method called Laser Induced Forward Transfer (LIFT) in combination with NSL to reduce the dimension of the metallic (gold) nanostructures in order to further boost the SERS signal.

Session 4 17:10

Etienne Brasselet, LOMA, Université de Bordeaux, Talence, France

Title: Singular micro-optical elements from direct femtosecond laser photopolymerization (VULRC)

Abstract: Direct femtosecond laser photopolymerization is used to fabricate high resolution microscopic optical elements endowed with singular features. Monolithic spiral phase plates and helical axicons are realized and provide precise delivery of the orbital angular momentum of light. The optical performances of the fabricated three-dimensional singular microstructures are experimentally measured and compared with their expected theoretical behavior, both in intensity and phase. The proposed approach thus merges the field of singular optics with that of integrated optics.

Session 4 17:30

Francisco José Gontad Farina, Department of Mathematics and Physics, University of Salento, Lecce, Italy

Title: Picosecond and sub-picosecond pulsed laser deposition of copper thin films (ULF-FORTH)

Abstract: We propose a new photocathode configuration which presents the quantum efficiency and work function of yttrium (Y) and, at the same time, preserves all of the advantages of copper (Cu) when inserted into a radio-frequency gun. The configuration consists of a disk of Y covered by a coating of Cu deposited using the pulsed laser ablation technique, while masking the central part of the Y disk by a shield making the photoemission directly from the Y bulk possible. The new device, built by pulsed laser deposition with a pulse duration of 5 and 0.5 ps, was characterised by scanning electron microscopy to deduce the morphology and by X-ray diffraction to obtain structure information on both Cu film and Y substrate.

Tuesday September 30, 2014

Session 5 10:40

Lorenzo Torrisi, Physics Department, Messina University, Messina, Italy

Title: Advanced targets to increase the electric field of on driven acceleration in TNSA regime at PALS

Abstract: Using the laser facility at PALS laboratory, at about 10^{16} W/cm^2 intensity, 300 ps pulse duration and 1315 nm wavelength, it is possible to irradiate thin foils in TNSA regime to accelerate ions in forward direction above 1 MeV per charge state. Such acceleration method can be controlled thanks to fast on-line plasma diagnostics based on the use of ion collectors and semiconductor detectors connected in time-of-flight configuration, Thomson parabola spectrometer and X-ray streak camera. Advanced targets can be employed to reduce the laser energy lost for reflection, scattering and transmission effects in the thin foil. Particularly, the use of targets promoting the absorption at the laser wavelength permits to transfer more energy to the electrons of the target surface that can be emitted from the rear side of the foil. The ions, subsequently to Coulomb explosion, are driven by the electron emission acquiring high kinetic energy. The use of advanced targets containing metallic nanostructures and nanoparticles, inducing surface plasma resonance effects, and of peculiar irradiation conditions, permits to enhance the proton yield and the ion energy, up to accelerations of the order of 5 MeV per charge state.

Session 5 11:00

Christopher Arrell, EPFL SB ISIC LSU CH H1, Lausanne, Switzerland

Title: Frustrated proton transfer in liquid water probed with time resolved VUV photoelectron spectroscopy (CLF)

Abstract: Time resolved photoelectron spectroscopy of liquid water was used to measure the frustrated proton transfer in liquid water. A liquid microjet (24 µm diameter) was excited with 2 µm laser pump and probed with a 40 fs VUV (39 eV) probe pulse. The results point to the initial formation of an OH--H+ dissociative pair, which then recombines to H2O due to ultrafast energy dissipation. A micro liquid jet capable of producing several millimeters of laminar flow was used under high vacuum conditions (10-6 mbar). Using the high harmonic source and time preserving monochromator at the Artemis laser facility at the Rutherford Appleton labs, and a novel differentially pumped time of flight electron spectrometer, the valence bands of liquid water were measured from the HOMO (1b1, liquid binding energy 10.9 eV) to the 2a1 (binding energy of 32 eV).

In summary we report on the first direct observation of the correlated proton transfer and dipole-dipole coupling dynamics in liquid water on the fs time scale using ultrafast VUV photoelectron spectroscopy. This new development now opens the liquid phase valence and core levels to exploration in the femtosecond time domain.

Session 5 11:20

Alois Bonifacio, University of Trieste, Trieste, Italy

Title: Lasers and sustainable energy from bacteria: SERS spectroscopy of biofilms in microbial fuel cells (LLAMS)

Abstract: Microbial fuel cells (MFCs) are bioelectrochemical devices used to obtain electrical energy from organic matter, and represent an interesting and promising technology for sustainable energy production, coupled to waste water treatment. In such devices, bacteria deposited on metal electrodes are used to break down organic matter, as that found in waste water, to produce electricity. SERS spectroscopy, a vibrational spectroscopy in which nanostructured metallic surfaces are used to enhance the otherwise weak Raman spectroscopic signal obtained by laser excitation, can be used to characterize the interaction between the bacterial biofilm and the electrodes used in MFCs. In fact, SERS spectroscopy is capable of investigating the nature biofilm-electrode interface, which is of the uttermost importance for the understanding of MFCs, as well as for their optimization.

Session 5 11:40

Jason Greenwood, Queen's University Belfast, UK

Title: Ultrafast Electron Dynamics in Amino Acids Initiated by Attosecond Pulses (CUSBO)

Abstract: We report the application of isolated attosecond pulses to prompt ionization of the amino acid phenylalanine and the subsequent detection of ultrafast dynamics on a sub-5-fs temporal scale, which is shorter than the vibrational response of the molecule. The ability to initiate and observe such electronic dynamics in polyatomic molecules represents a crucial step forward in attosecond science, which is progressively moving towards the investigation of more and more complex systems.

Postdeadline papers:

Davide Bossini, Radboud Universiteit

Ultrafast laser-induced spin dynamics at the edge of the Brillouin zone in the antiferromagnet KNiF3 (CUSBO)

Abstract: In the last decade one of the major research activity in material science has been aimed at controlling the macroscopic phases of solids with light pulses on the sub-picosecond time scale [Rini2007, Fausti2010]. In particular, the possibility to manipulate the magnetic ordering of a medium with an ultrafast stimulus is of main interest [Kirilyuk2010]. The investigation of antiferromagnetic (AFM) materials, though representing the overwhelming majority of magnetically ordered materials, is still in its infancy. In fact only the first magnetic excited state, the so called one-magnon mode, has been impulsively triggered via Stimulated Raman scattering [Kimel2005,Satoh2012]. This process is mediated by the spin-orbit coupling in the excited state. In fact, it was experimentally demonstrated even for materials with quenched spin-orbit coupling in the ground state and in zero-dissipation conditions [Bossini2014]. However the dynamics of the higher energy magnetic modes is totally unexplored. In particular, the so-called two-magnon mode [Cottam1986] is of terrific scientific interest, since it is defined by couples of high wave vector interacting magnons. Consequently this mode is strongly connected with the exchange interaction, which dominates the spin waves dispersion far from the center of the Brillouin zone. In this talk I will present our pioneer investigation of the ultrafast dynamcs of the two-magnon mode in the antiferromagnet KNiF3. The unprecedented time resolution of the laser pulses generated in the CUSBO lab allowed us to excite the high frequency (22 THz) spin excitation via ISRS. We observed the response of the spin system to the laser stimulus by measuring the transient magneto-optical effect. Our preliminary results confirmed the nature of the excited mode via the measurement of the temperature dependence and the characterization of the symmetry of the effect. The dynamics of the magnon-magnon interaction and of the exchange interaction are currently under investigation.

Swen Künzel, Instituto Superior Técnico, Lisboa, Portugal

Title: Refraction compensation in a two-stage seed-amplifier XRL (GSI)

Abstract: In continuation of successful experiments within the last two years we set-up a two-stage, seed-amplifier x-ray laser with a large active volume amplification stage, using the PHELIX beam in the x-ray laser laboratory at PHELIX. We used a triple pulse consisting of one pre-pulse and two short pulses to optimise the seed and amplifier emission. Using this scheme we observe a seed output energy of ~0.5 μJ and an amplification factor of 4.5.