WG6 STUDENT POSTERS (Monday, 7/28, 3:30-6:30)

1. **Status of Coherent Cherenkov Wakefield Experiment at UCLA**

Alan Cook (UCLA). O.B. Williams (UCLA Department of Physics), R. Tikhoplav (UCLA Department of Physics), G. Travish (UCLA Department of Physics), J. B. Rosenzweig (UCLA Department of Physics), A. Knyazik (UCLA Department of Physics)—Coherent Cherenkov radiation wakefields are produced when a compressed electron beam travels along the axis of a hollow cylindrical dielectric tube. In a dielectric wakefield accelerator (DWA) these wakefields accelerate either a trailing electron bunch or the tail of the driving bunch, depending on the modal structure of the radiation. For an appropriate choice of dielectric structure geometry and beam parameters the device operates in a single-mode regime, producing sinusoidal wakefields with wavelengths in the THz range. We report on preliminary results of an experiment at UCLA studying the potential of a DWA structure to produce high-power, narrow-band THz radiation.

2. **Simulation of Weibel Instability for LWFA and PWFA Electron Beams**

Brian Allen (University of Southern California), Tom Katsouleas (katsoule@usc.edu), Patric Muggli (muggli@usc.edu), Anatoly Maksimchuk (tolya@umich.edu), Vitaly Yakimenko (yakimenko@bnl.gov), Bing Feng (bfeng@usc.edu)—Weibel instability is of central importance for the propagation of relativistic beams in plasmas both in laboratory, ex. fast-igniter concept for inertial confinement fusion, and astrophysical, ex. cosmic jets. Simulations, using QuickPic, of an intense and monoenergetic beam propagating through a plasma were conducted for experimental conditions with Laser Wakefield and RF accelerators beams and show the appearance of Weibel instability (or current instability). The appearance of the instability is investigated as a function of beam parameters (density, spot size and bunch length) and plasma parameters (plasma density and length). We present preliminary simulation results, discuss further simulation refinements and outline potential future experiments. Work was supported by the US Department of Energy.

3. **OTR Measurement for Laser Plasma Accelerated Electron Beam**

Chen Lin (LBNL), Anthony Gonsalves (LBNL, Mail Stop 71J-100A), Wim Leemans (LBNL, Mail Stop 71J-100A), Kei Nakamura (LBNL, Mail Stop 71J-100A)—When the electron bunch created in the capillary discharge guided LWFA passes through an aluminum foil, it will produce optical transition radiation(OTR) signal. OTR can provide information about the energy, the energy spread, the spot size and the divergence of the electron bunch. Because of the LWFA-produced electron bunches have short bunch length (5-50fs) and low charge (tens of pC), this OTR signal has some special characters. One challenge is that after interaction with plasma, the high intensity laser light with broaden spectrum will completely cover it. So several implementation have been set and tested. In the mean time, we set up a phosphor screen at the end of the vacuum chamber to observe the size of electron bunch. After calibration of the phosphor screen and CCD, this set up can also give the information of beam charge.

4. **Towards a robust, efficient dispenser photocathode: the effect of re-cesiation on quantum efficiency**

Eric J. Montgomery (University of Maryland, College Park), Donald W. Feldman (IREAP, University of Maryland, College Park MD 20742), Zhigang Pan (IREAP, University of Maryland, College Park MD 20742), Jessica Leung (IREAP, University of Maryland, College Park MD 20742), Patrick G. O'Shea (IREAP, University of Maryland, College Park MD 20742), Kevin L. Jensen (Code 6843, ESTD, Naval Research Laboratory, Washington D.C., 20375-5347)—Future electron accelerators and high power Free Electron Lasers (FELs) require high brightness electron sources; photocathodes for such devices are challenged to maintain long life and high electron emission efficiency (high quantum efficiency, or QE). The UMD dispenser photocathode prototype addresses this tradeoff of robustness and QE. In such a dispenser, a cesium-based surface layer is deposited on a porous substrate. The surface layer can be replenished from a subsurface cesium reservoir under gentle heating, allowing cesium to diffuse controllably to the surface and providing demonstrably more robust QE. In support of the premise that re-cesiation is able to restore contaminated cathodes, we here report controlled contamination of cesium-based surface layers with subsequent re-cesiation and the resulting effect on QE. Contaminant gases investigated are those known from the vacuum environment of typical electron guns. The use of argon ion cleaning of the cathode substrate and its importance for obtaining atomically clean surfaces is also detailed. This project is funded by the Joint Technology Office and the Office of Naval Research.

5. Generation and transport of space charge waves in the University of Maryland Electron Ring

B.Beaudoin (beaudoin@umd.edu), D.Feldman (dfeldman@umd.edu), R.Kishek (ramiak@umd.edu), S.Bernal (sabern@umd.edu), P.O'Shea (poshea@umd.edu), M.Reiser (mreiser@umd.edu), D.Sutter (accelphy@aol.com)—An experimental study of longitudinal dynamics of space charge dominated beams is presented. We use drive-laser driven perturbations to study the evolution of space charge waves on an intense electron beam.Collective effects like propagation of space charge waves, superposition of waves and crossing of waves are presented and verified with 1-D cold fluid model theory. Multiturn transport of parabolic beam and other collective effects in UMER are discussed. This work is funded by US Dept. of Energy Offices of High Energy Physics and High Energy Density Physics, and by the US Dept. of Defense Office of Naval Research and Joint Technology Office.

6. Longitudinal Phase Space Measurement of Sub-Picosecond Photoinjector Blowout Regime Beam at UCLA Pegasus Laboratory

Joshua Moody (UCLA PBPL), Pietro Musumeci (), Cheyne Scoby (), Tan Tran (), Michael Guitierrez ()— We present the measurement of the longitudinal phase space of a uniformly filled ellipsoidal beam. The generation of such beams by ultrashort (~35fs RMS) laser pulses stimulating a photocathode was recently demonstrated at the UCLA Pegasus Laboratory. High resolution measurement of the longitudinal phase space was performed by mapping time and energy spread information onto the transverse beam profile by use of an X-band RF deflecting cavity and a dipole spectrometer. Longitudinal phase space dynamics are discussed with regard to beam parameters.

7. Towards a Laser Wake Field Accelerator driven EUV Free Electron Laser

Mike Bakeman (University of Nevada Reno), K.E. Robinson (KERobinson@lbl.gov), G. Bouquot (GBouquot@lbl.gov), W.M. Fawley (WMFawley@lbl.gov), Carl B Schroeder (CBSchroeder@lbl.gov), Kei Nakamura (KNakamura@lbl.gov), Csaba Toth (CToth@lbl.gov), Wim Leemans (WPLeemans@lbl.gov)— Currently there is great interest in using electron beams from Laser Wakefield Accelerators (LWFA) as drivers for "tabletop" EUV and x-ray wavelength free electron lasers (FEL). Experiments [1] at LOASIS have achieved quasi-mono-energetic, ~1-GeV beams as measured by a large 1-T magnetic spectrometer with a limiting resolution of 2%. By using an insertion device such as an undulator and by observing the spontaneous emission spectrum (including harmonics), electron beam energy spread and emittance can be measured simultaneously with great precision. Experiments are underway for coupling the THUNDER undulator [2] to the LOASIS LWFA. The predicted output spectra have been modeled numerically with the SPECTRA code [3] and show that the harmonic width provides a good measure of the electron beam energy spread. They also demonstrate that increasing beam emittance increases the amplitude of the even optical harmonics, which would not be present for a truly zero-emittance beam and perfect undulator alignment. The initial experiments will use the spontaneous emission in the 5-40 nm wavelength range from 1.5 m of undulator to characterize the beam, using an incident grazing EUV spectrometer as our primary diagnostic. Later experiments will use up to 5 m of undulator to produce a coherent, FEL gain. [1] W.P. Leemans et al., Nature Physics, Volume 2, Issue 10, pp. 696-699 (2006). [2] K. Robinson, IEEE Journal of Quantum Electronics, Volume 23, Issue 9, pp. 1497- 1513 (1987). [3] T. Tanaka and H. Kitamura, J. Synchrotron Radiation, Volume 8, pp. 1221 (2001)

8. Driving compact free-electron lasers with laser-accelerated electrons

S. I. Bajlekov (Oxford University), R. Bartolini (Department of Physics, University of Oxford, Denys Wilkinson Building, Keble Road, Oxford, OX1 3RH, U. K.; and Diamond Light Source, Rutherford Appleton Laboratory, Chilton, Didcot, OX11 0QX, U. K.), S. M. Hooker (Department of Physics, University of Oxford, Clarendon Laboratory, Parks Road, Oxford OX1 3PU, U. K.)—The prospect of driving compact sources of short-pulse, coherent x-rays with electron bunches from laser-plasma accelerators is attracting much attention. The parameters of the electron bunches produced by laser-driven accelerators are very favorable for this application. In particular, the characteristic size of the accelerating structure limits the bunch size to the micron level both in the longitudinal and transverse dimensions. This results in an unprecedented peak current of several kA, as well as low transverse emittance. These factors, together with demonstrated high energies and low energy spreads, make electron bunches from plasma accelerators a potential candidate for driving a free-electron laser operating in the soft x-ray or XUV regime. This poster presents a comprehensive study of the dynamics of such a process, illustrated using GENESIS simulations. The electron parameters are based on recent experimental results and short-term projections. Full consideration is given to electron bunch propagation between the accelerator and the undulator, including space-charge effects and emittance evolution. Despite these constraints, we demonstrate the possibility of generating radiation down to 5 nm with several GW peak power and peak brilliance on the order of 10^30 in standard units, within several meters. The short wavelength and femtosecond-order duration of such pulses makes them an exciting tool for time-resolved studies of biological processes and material structure dynamics. We present the temporal, spectral, and spatial characteristics of the resulting radiation field, with an emphasis on coherence properties. These are shown to be enhanced by using a high-quality radiation seed, such as one generated from higher harmonics of the same laser used for electron acceleration. The gain and saturation characteristics of free-electron lasers operating in such a short-wavelength regime are strongly dependent on the quality of the driving electron bunch. We present this dependence for a range of wavelengths, to give an insight into the electron bunch parameters that are critical for attaining shorter wavelengths, minimizing saturation length and maximizing output intensity. We identify key issues that need to be addressed, such as shot-to-shot stability, and evaluate current efforts in the field.

9. **Modeling Surface Coverage Evolution of Cesium on future Dispenser Photocathodes to Optimize their Design**

Zhigang Pan (University of MD College Park), E. J. Montgomery (University of Maryland), P. G. O'Shea (University of Maryland), K. L. Jensen (Naval Research Laboratory), J. L. Shaw (Naval Research Laboratory), J. E. Yater (Naval Research Laboratory)—Dispenser photocathodes are among the leading options for a robust and efficient source of bright electron beams required by next generation Free Electron Lasers (FELs). Many high efficiency photocathodes enable enhanced quantum efficiency (QE) of electron emission by using a sub-monolayer surface coating of cesium that effectively lowers the surface work function of the material, and increases the ratio of photoemitted electrons to incident photons. High QE cesiated photocathodes, however, are notorious for their short lifetime, which can in part be attributed to cesium loss at the cathode surface during operation. Dispenser photocathodes offer promise in-situ rejuvenation of cesium at the surface by dispensing cesium atoms from a gently heated reservoir located below the cathode through source pores leading up to the surface. As the cesium atoms come up through the pores, they diffuse and migrate across the cathode surface altering the surface coverage. At UMD we have made progress in demonstrating experimentally that the dispenser cathode concept can indeed significantly extend the lifetime of cesiated metal photocathodes [1]. In order to optimize future dispenser cathode designs, we need a predictive model of cesium diffusion onto and across the cathode surface. Our goal is to model surface coverage during rejuvenation as a function of dispenser design and operating parameters. We shall discuss in this report progress towards a numerical algorithm currently being developed in Matlab that is aimed at modeling the surface evolution of cesium coverage, as well as progress in measuring and isolating the parameters of interest that govern the surface evolution of cesium in the model.

WG6 POSTER SESSION (Thursday, 7/31, 3:30 – 5:00)

10. **Generating polarized high-brightness muon beams with high-energy gammas.**

V. Yakimenko (BNL)—Hadron colliders are impractical at very high energies as effective interaction energy is a fraction of the energies of the beams and luminosity must rise as energy squared. Further, the prevailing gluon-gluon background radiation makes it difficult to sort out events. e+e- colliders, on other hand, are constrained at TeV energies by beamstrahlung radiation and also by cost as long linacs are required to avoid synchrotron radiation in the rings. A muon collider will have the same advantages in energy reach as an e+e- collider, but without prohibitive beamstrahlung- and synchrotron- radiation. Generation of the high-brightness polarized muon (m-m?-? beams through gamma conversion into pairs in the nuclei field is considered in this paper. The dominant effect in the interaction of the high-energy photons with the solid target will be the production of electron-positron pairs. The low-phase space of the resulting muon beams adequately compensates for the small probability of generating a m-m+ pair.

11. Generation of THz surface plasmons using a compact electron accelerator

W. Op't Root (Eindoven U.), O.J. Luiten (), P.W. Smorenburg ()—When a relativistic electron passes perpendicularly through a metal foil, surface currents are induced which give rise to so-called transition radiation. The transition radiation is emitted in the form of two radially polarized, broadband radiation pulses, one in the forward and one in the backward direction, in a narrow cone centered on the electron trajectory. The energy of the transition radiation pulses is of the order of 1 eV, negligible compared to the MeV kinetic energy of the electron. The recently developed combination of femtosecond photoemission with radiofrequency (RF) accelerator technology, make it possible to create MeV, sub-100 fs electron bunches containing more than 100 pC of charge. If such a bunch is sent through a metal foil, the transition radiation fields emitted by the individual electrons add up coherently at wavelengths larger than the bunch size, implying that the energy radiated per electron at THz frequencies is amplified by a factor equal to the number of electrons in the bunch. Calculations show that in this way THz pulses may be created with a bandwidth of 10 THz and an energy of 10 microJ. Focused to a small spot, this would give rise to peak electrical fields of 10 MV/cm and higher. If the electrons impinge on the metal surface at grazing incidence rather than at right angles, the interesting possibility arises of creating a THz surface plasmon polariton (SPP). For example, if the angle between the electron bunch trajectory and an ideal metal surface is equal to gamma-1, where gamma is the relativistic Lorentz factor, then the electron velocity is perfectly matched to the SPP propagation speed. A coherently amplified THz SPP will then be created, containing a significant fraction of the kinetic energy of the electron bunch. By aiming the electron bunch at a tapered metal wire, a giant radially polarized SPP will be generated, which can be guided conveniently along the wire. In this case the coupling is particularly efficient because the radial Coulomb field of the bunch is naturally matched to the polarization of the SPP wire mode. To show the potential of the above proposed method we have calculated the radiation fields created by an electron bunch impinging on a perfectly conducting semi-infinite cone. We have linked the results to the electric field strength and duration of the SPPs that are excited and propagate along the metal wire. The calculations shown that using currently available electron bunches, it is possible to generate sub-picosecond SPP pulses with peak electric fields of the order of MV/cm on a 1 mm diameter wire. A 5 MeV RF photo-electron accelerator with a footprint smaller than the 1 mJ, 30 fs Ti-Sapphire photoemission laser has been built and tested. Both foil and wire experiments are in preparation.

12. Comissioning of Alkali-antimonide photocathode at U-tokyo RF gun

Mitsuru UESAKA (U. Tokyo), Akira SAKUMI (2-22, Shirakata-Shirane, Tokai, Naka, Ibaraki, JAPAN), Toru UEDA (2-22, Shirakata-Shirane, Tokai, Naka, Ibaraki, JAPAN), Hiromitsu TOMIZAWA (1-1-1, Koto, Sayo-cho, Sayo-gun, Hyogo, JAPAN), Kunihiro MIYOSHI (2-22, Shirakata-Shirane, Tokai, Naka, Ibaraki, JAPAN), Kota KANBE (2-22, Shirakata-Shirane, Tokai, Naka, Ibaraki, JAPAN)—We have been developing a compact-sized cartridge-type cathode exchanging system installed in BNL-type IV photocathode RF gun. We can replace a cathode without breaking the vacuum of RF gun, so that a high quantum efficiency photocathode is not surrounded by oxygen or moisture. We propose the Na2KSb cathode, which has the possibility to drive by visible light of 400 nm (violet range). The work function of Na2KSb is 2.4 eV, which is lower than the photon energy of 400 nm. We tested the cathode and obtained the quantum efficiency of 1% at the wavelength of 266nm. The electron charge reaches 3 nC after accelating by 18 MeV linac. The lifetime of T1/2 is more than 100 hours surrounded at the vacuum pressure of 4*10-8 Torr. The cathode works more than 500 hours, though the quantum efficiency is decreased to less than 0.1 %.

13. X-band Deflector for Beam Manipulation in Synchrotron Storage Rings

V.A. Dolgashev (SLAC)—The use of deflecting structures for producing short x-ray pulses in synchrotron storage rings has been proposed by A. Zholents et al., (NIM A 425, 385 (1999)). In the present report normal conducting X-band deflectors are considered for the beam manipulation. The deflectors have to produce up to 1 MV deflection. At the same time, they should not cause deterioration of beam properties in a storage ring. To satisfy this, the beam pipe has to be large and highly overmoded at the cavity frequency. Following these requirements, we propose to use as deflectors 11.424 GHz standing wave cavities with heavy wakefield damping.

14. High efficiency terahertz source from femtosecond laser-aligned molecules

Andy York (UMD)—Ultra-short pulse THz radiation is of importance for low density plasma and beam diagnostics, both important for advanced accelerators. Intense short terahertz pulses (> 10 microjoules, < 5 cycles), however, are still only produced at large accelerator facilities like BNL [1]. Chirped pulse amplification is theoretically possible for terahertz frequencies, but no broadband lasing medium like Ti: Sapphire has been demonstrated for terahertz. We present simulations showing that laser-aligned molecules can amplify broadband terahertz radiation, allowing high-energy amplification of few-cycle pulses at terahertz frequencies [2]. Saturated energy extraction in laser-aligned HCN can exceed hundreds of microjoules per cubic centimeter per atmosphere of pressure, with gain from 0.08 to 1.6 terahertz. We discuss the effects of collisions and temperature on pumping and gain, and discuss two experimental configurations. 1. Y. Shen, T. Watanabe, D. A. Arena, C.-C. Kao, J. B. Murphy, T. Y. Tsang, X. J. Wang, and G. L. Carr, Phys. Rev. Lett. 99, 043901 (2007). 2. A. York and H.M. Milchberg, Optics Express 16, 10557 (2008).

15. A High-Brightness Circular Charged-Particle Beam System

Jing Zhou (MIT)—A method is presented for the design of a high-brightness non-relativistic circular beam system including a charged-particle emitting diode, a diode aperture, a circular beam tunnel, and a focusing magnetic field that matches the beam from the emitter to the beam tunnel [1]. The applied magnetic field is determined by balancing the forces throughout the gun and transport sections of the beam system. The method is validated by three-dimensional simulations. The recently developed adiabatic equilibrium theory for an intense, axisymmetric charged-particle beam propagating through a periodic solenoidal focusing field [2] is used to address the thermal effects that might be present in such a high-brightness charged-particle beam system. The thermal beam distribution function is constructed. The theory is compared to a recent high-intensity beam experiment performed at the University of Maryland Electron Ring (UMER) and good agreement is found. Such a high-brightness charged-particle beam system may find applications for generating high-brightness electron or ion beams for accelerators. [1] T. Bemis, R. Bhatt, C. Chen and J. Zhou, ?A high-brightness circular charged-particle beam system,? APPLIED PHYSICS LETTERS 91, 201504 (2007). [2] J. Zhou, K. Samokhvalova and C. Chen, ?Adiabatic Thermal Equilibrium for Axisymmetic Intense Beam Propagation,? Physics of Plasmas 15, 023102 (2008).

16. Initial Characterization Results of the BNL ATF Compton X-ray Source Using K-edge Absorbing Foils

Oliver Williams (UCLA)—Compton scattering-based x-ray sources are quickly gaining popularity as compact, cost-effective radiation sources rivaling 3rd generation synchrotron rings in peak brightness. Few studies have been done, however, in fully characterizing a Compton x-ray source for user applications. Using various foils with K-edges in the many keV energy range, beam parameters can be chosen such that on-axis photons are above the K-edge for a given material, where absorption is very strong and there is no transmission. Photons observed off-axis are red-shifted and fall below the K-edge, therefore being transmitted and creating a ?donut? pattern in the ideal case. Starting with photon energies below the K-edge and aperturing for small angles on-axis allows one to scan the electron beam to higher energy until all scattered photons are above the K-edge and absorbed, thus presenting a method of bandwidth measurement. We present initial experimental results of the bandwidth and double differential spectrum (DDS) for angle and energy of Compton photons generated at the BNL ATF.

17. Longitudinal Control of Space-Charge Dominated Beams in the University of Maryland Electron Ring

Brian Beaudoin (Institute for Research in Electronics and Applied Physics), P.G. O'Shea (Institute for Research in Electronics and Applied Physics), S. Bernal (Institute for Research in Electronics and Applied Physics), R.A. Kishek (Institute for Research in Electronics and Applied Physics), M. Reiser (Institute for Research in Electronics and Applied Physics), D. Sutter (Institute for Research in Electronics and Applied Physics), J.C.T. Thangaraj (Institute for Research in Electronics and Applied Physics)—Longitudinal stability of beams is fundamental to the stable operation of all accelerators, particularly for free electron lasers where the microbunching instability can lead to unwanted coherent synchrotron radiation in bends. Longitudinal space charge forces in the beam are responsible for the development of energy and density modulations induced from perturbations. Space charge is also responsible for the expansion of the beam ends. This paper presents experimental results on using an induction cell to longitudinally focus the bunch in the University of Maryland Electron Ring (UMER), a scaled accelerator using low-energy electrons to model space charge dynamics. With this type of focusing, errors in the applied fields can cause energy perturbations in the flat-top region of the beam inducing space-charge waves and thus distorting the current profile. In the experiments, we also use the induction cell to deliberately introduce energy modulations onto the beam. Comparison with theoretical models is also shown. * This work is funded by US Dept. of Energy Offices of High Energy Physics and High Energy Density Physics, and by the US Dept. of Defense Office of Naval Research and Joint Technology Office. Keywords: electron, focusing, induction cell, energy perturbations, space-charge waves.

18. **Beam dynamics simulations of the transverse-to-longitudinal emittance exchange proof-of-principle experiment at the Argonne Wakefield Accelerator**

Marwan Rihaoui (NIU)—Transverse-to-longitudinal emittance exchange has promising applications in various advanced acceleration and light source concepts. At, the Argonne Wakefield Accelerator, we are currently working toward a proof-of-principle experiment to demonstrate this phase space manipulation method. The experiment focuses on exchanging a low longitudinal emittance (3 microns) with a high transverse horizontal emittance value (10 microns) and also incorporates room for possible parametric studies e.g. using an incoming flat beam with tunable horizontal emittance. In this paper, we present realistic start-to-end beam dynamics simulation of the scheme, explore the limitations of this phase space exchange, and summarize the current status of the experiment.

19. **Measurement of x-ray betatron radiation from laser accelerated electron beams**

V. Leurent, P. Michel, C. E. Clayton, B. Pollock, T. Doeppner, T. L. Wang, J. Ralph, A. Pak, C. Joshi, G. Tynan, L. Divol, J. P. Palastro, S. H. Glenzer and D. H. Froula—New laser wakefield acceleration (LWFA) experiments have been carried out at the Callisto Laser Facility, Lawrence Livermore National Laboratory. We will present results of the first experimental campaign on LWFA. The electron beam energy spectrum was measured with a two-screen spectrometer to avoid ambiguities due to the possible angle of the electron beam at the plasma exit [1]. Electron beams up to 200 MeV were measured. X-ray betatron radiation from the accelerated electrons were also measured. By using a set of filters acting like a spectral step function, the x-ray spectrum was reconstructed from fitting theoretical estimates; the radiation peaks at a few keVs. [1] R. Ischebeck et al., Proceedings of PAC 2007, Albuquerque NM, p. 4168. This work is supported by LDRD 08-LW-070 and performed under the auspices of the U.S. Department of Energy by LLNC under contract DE-AC52-07NA27344.

20. **Compression of an ultrashort laser pulse via self-modulation in argon plasma channel**

Masashi Kudo (Utsunomiya University, Japan), Takeshi Higashiguchi (Utsunomiya University, Japan), Noboru Yugami (Utsunomiya University, Japan)—Ultrashort laser pulse is provided in the strong-electric field science, such as x-ray lasers, high-order harmonic generations, and charged-particle accelerations. Pulse compression phenomenon through nonlinear propagation has been widely studied. The pulse compression is mainly based on spectrum broadening produced by a self-phase modulation in the nonlinear medium. A gas-filled hollow optical fiber have been used as the nonlinear medium to broaden the spectrum [1]. The incident pulse energy, however, was limited to a few mJ level due to the low damage threshold of the fiber. Recently, a 7.4-fs pulse with a 2-mJ energy were obtained by using the gas-cell without the hollow optical fiber-filled with noble gas [2]. Ultrashort laser pulse is also interested in the ultrafast plasma diagnostics and the probing the plasma wave. In this paper, we show the compression of an ultrashort laser pulse with 20-30 mJ through the argon gas-filled plasma channel. The laser source used in the present experiment is a commercial chirped-pulse-amplified Ti:Sapphire laser system operating at 10 Hz repetition rate, producing 50 mJ/pulse, and 120-140 fs in duration with a center wavelength at 797 nm. Typically, the bandwidth (FWHM) of the pulse is about 8 nm. The beam is focused by an f = 1.5 m lens into an argon gas-filled gas-cell. After passing through its gas-cell, the compressed laser pulse duration and its phase were measured by the auto-correlator and the spectral phase interferometry for direct electric-field reconstruction (SPIDER), respectively. The shortest pulse duration of less than 80 fs (FWHM) with 30 mJ was observed. We also observed the split pulse at the low laser energy and the low argon gas pressure, which was attributed to the plasma filaments in the plasma channel. [1] M. Nisoli et al., Appl. Phys. Lett. 68, 2793 (1996). [2] S. Skupin et al., Phys. Rev. E 74, 056604 (2006).

21. Frequency upshift and radiation of the THz electromagnetic wave via an ultrashort-laser-produced ionization front

Hideyuki Hasegawa (Utsunomiya University, Japan), Hirofumi Nishimai (Utsunomiya University, Japan), Takeshi Higashiguchi (Utsunomiya University, Japan), Noboru Yugami (Utsunomiya University, Japan), Patric Muggli (USC, USA)—Light sources in the terahertz spectral region are developing for various potential applications in the novel diagnostics such as testing of semiconductor materials, determining complex refractive index and electric conductivity. The photo-conductive (PC) antenna based on transitional current modulation emits ultrashort pulse with broad spectrum. The power of THz emission source such as PC antenna, however, is low in the order of nW level. A plasma-based frequency upshift of the radiation can directly convert from periodic (electrostatic and/or electromagnetic) wave to upshifted-wave in the laser-plasma physics point of view. The radiation frequency of the upshifted-electromagnetic wave depends on the laser-produced plasma density behind the relativistic or superluminous ionization front [1]. The characteristics of THz source are capable of controlling the radiation frequency and emitting power with short pulse. In our experiments, the temporal waveform of the THz emission was measured by use of a PC antenna sampling diagnostic. In the DARC (DC to AC radiation converter) scheme, two cycles wave with a period of 0.8 ps was observed. The Fourier transformed spectrum of the temporal signal THz waveform has a peak of 1.2 THz with a bandwidth of 0.7 THz (FWHM). The DARC theory indicates that the frequency broading is proportional to the 1/N, where N stands for the number of the initial electrostatic waves. The relative bandwidth was observed to be 0.6. [1] W. B. Mori et al., Phys. Rev. Lett. 74, 542 (1995).