Schedule for presentations at the AAC Workshop 2008
(Working Group 1: laser plasma acceleration)

Tuesday

(1) 7/29 11 am - 12 pm **High power experiments I**

WG1-1	**Laser-driven acceleration in plasma waveguides (20 minutes)** In order to increase the energy of beams generated in a laser-driven accelerator it is necessary to operate at lower plasma densities and maintain acceleration over longer lengths. In practice, acceleration to energies of several GeV in a single stage will require acceleration over several tens of millimetres and in turn this necessitates that the driving laser pulse is channeled in some way. Plasma channels offer one method by which high-intensity laser pulses may be channeled over distances long compared to the Raleigh range. One method for generating plasma channels of this type is the gas-filled capillary discharge waveguide. In this device, capillaries of 200 - 400 um diameter are filled with hydrogen gas to an initial pressure of tens or hundreds of millibar. A discharge pulse of peak current ~200 A, and duration ~250 ns is passed through the capillary to ionize the gas; a plasma channel is formed as a consequence of the temperature gradient established by heat conduction to the capillary wall. The matched spot size of the plasma channel is typically 20 - 40 um. We describe several experiments in which plasma accelerators are driven within gas-filled capillary discharge waveguides. In experiments performed at Lawrence Berkeley National Laboratory laser pulses with peak power of up to 40 TW were guided in a 33 mm long channel to generate quasi-monoenergetic electron beams with energies up to 1 GeV. In work performed with the Astra laser at the Rutherford Appleton Laboratory, laser pulses with a peak power of 13 TW were used to generate electron beams with energies of up to 200 MeV. It was found that electron beams were only generated under conditions in which a plasma channel was formed. Injection and acceleration of electrons was found to depend sensitively on the delay between the onset of the discharge current and the arrival of the laser pulse but, importantly, to be highly reproducible. A comparison of spectroscopic and interferometric measurements allowed the degree of ionization of the plasma channel to be determined for the first time, and strongly suggests that in these experiments injection was assisted by laser ionization of atoms or ions within the channel. If confirmed, this mechanism offers a new way of controlling the process of electron injection in a laser-driven accelerator. Finally we will report the initial findings of experiments presently being undertaken with the Gemini laser at the Rutherford Appleton Laboratory. In these experiments laser pulses with a peak power up to 80 TW have been guided through plasma channels up to 50 mm long to generate monoenergetic electron beams in excess of 0.5 GeV.	Simon Hooker (Oxford)
WG1-2	**Laser wakefield acceleration experiments at the University of Michigan (20 minutes)** Laser plasma interaction at the relativistic limit is an active research field, with focus on laser wakefield acceleration schemes (LWFA) but also with application to basic science experiments studying nonlinear interaction phenomena. A critical condition for realizing stable GeV-class LWFA is control of electron injection into the wakefield at the low plasma densities necessary to avoid dephasing between the driving laser pulse and the accelerated electron beam. The HERCULES laser facility at the University of Michigan has recently upgraded up to 200 Terawatts (TW) of laser power and has been dedicated to exploring the electron injection mechanism. It is expected that increased power facilitates the wavebreaking of plasma waves, one mechanism of electron injection. Experiments have shown	Takeshi Matsuoka (Michigan)

	that the charge of an accelerated electron beam increases rapidly with laser power after a threshold value for a fixed plasma density. A stable electron beam was obtained with maximum electron energy of 200 MeV for laser power ranging from 40 to 100 TW, where the maximum energy is limited by the gas-jet length (2.2 mm). It was also found that improving the focal spot of the laser with a deformable mirror substantially increased the electron charge. Faraday rotation diagnostics were implemented to better understand the electron injection mechanism by measuring self-generated magnetic field of the accelerated electron beam. All experimental results imply that electron injection is enhanced for greater laser intensity. Similarly, using ablated plasma created with an external, low-power nanosecond laser as the LWFA media also successfully produced stable ~100 MeV electron beams with quasi mono-energetic features. In this experiment the electron injection is likely assisted by optical field ionization seeding in the ablated plasma. Several additional aspects of laser plasma interaction were also studied. Betatron motion of electrons in plasma is observed in these experiments at the LWFA parameters and might be suitable for generating x-ray radiation. Discussion of other laser plasma interactions including stimulated Raman scattering, soliton formation, and ion acceleration by the radial ponderomotive force of the laser are also presented in the talk.	
WG1-3	**Electron acceleration at MPQ - Stable laser-wakefield accelerator with pointing control (20 minutes)** Laser plasma accelerators are able to produce high quality electron beams from 1 Mev to 1 GeV. We now look at designing laser wakefield accelerators to reach energies from 10 GeV to 1 TeV using PetaWatt laser powers and staging. This next generation of plasma accelerator experiments will use a two-stage approach where a high quality electron bunch is first produced and then injected into an accelerating stage functioning in the quasi-linear regime. In this talk I will present scaled particle-in-cell simulations of a 10 GeV stage. Physical parameters are scaled to be able to perform these simulations at reasonable cost. Properties of the electron beam produced are determined (charge, energy, energy spread, emittance), and parameter regimes are scanned to optimize the quality of the electron bunch at the output of the stage.	Stefan Karsch (MPQ)

(2) 7/29 1:30 pm - 3 pm **High power experiments II**

WG1-4	**Laser Wakefield Acceleration at Lawrence Livermore National Laboratory (20 minutes)** Recent laser wakefield acceleration experiments at the Jupiter Laser Facility, Lawrence Livermore National Laboratory, will be discussed.	Dustin Froula (LLNL)
WG1-5	**Generation of GeV-electron bunches from laser-plasma interactions in gas jets (20 minutes)** The electron sheath surrounding the cavitation region in a blowout laser wakefield emits electro-optic shock radiation. The radiation is at the second harmonic of the pump and is emitted into a Cherenkov type angle. We present an analysis that relates the radiation characteristics to the form of the plasma bubble, and compare with three dimensional particle-in-cell simulations. Preliminary experimental results will also be presented. This unique form of radiation might be an interesting diagnostic tool for laser wakefield accelerators.	Nasr Hafz (PRI, GIST. South Korea)
WG1-6	**Trapping and destruction of long range high intensity optical/plasma filaments (20 minutes)** The propagation of few millijoule femtosecond laser pulses through gases routinely drives a large nonlinear response in the constituent atoms and molecules. This response is central to the extremely long range filamentary propagation of ultrashort optical pulses in the atmosphere [1]. Long range filaments are accompanied by plasma generation and co-propagating coherent white light generation. Femtosecond laser pulses also drive thermal samples of molecular	Howard Milchberg (Maryland)

	gases into alignment [2]. An aligning pulse induces a coherent rotational wavepacket in each molecule that causes molecular alignment to reoccur at regular intervals well after the pulse has left. The recurrent molecular alignment propagates in the wake of the optical pulse. We have previously taken single-shot, time- and space-resolved measurements of the initial and recurrent quantum rotational alignment of many molecular gases and its effect on the spectral and spatial profile of a co-propagating, weak probe pulse [3]. Because a femtosecond pulse filamenting in atmosphere maintains high intensity over a great distance, it is followed by an extended quantum wake of aligned nitrogen and oxygen molecules. Here we demonstrate that the molecular alignment quantum wake following a pump pulse filamenting in air has a dramatic effect on the propagation of an intense probe pulse filament. For slight angular misalignment of pump and probe we find, depending on delay, that the rotational quantum wake either transversely pulls and focuses the probe filament into the pump filament path, or destroys it. We also confirm that for moderate pulse lengths > 100 fs, the dominant air nonlinearity in single pulse filamentation is rotational. Accompanying probe pulse spectrum measurements are consistent with quantum wake trapping. Our results demonstrate that long range filamentary propagation can be controlled by exploiting the coherent temporal and spatial response of air molecules. [1] A. Couairon and A. Mysyrowicz. Physics Reports 441, 47 (2007) and references therein. [2] H. Stapelfeldt and T. Seideman, ?Aligning molecules with strong laser pulses,? Rev. Mod. Phys. 75, 543- 557 (2003). [3] Y.-H. Chen, S. Varma, A. York, and H. M. Milchberg, "Single-shot, space- and time- resolved measurement of rotational wavepacket revivals in H2, D2, N2, O2, and N2O," Opt. Express 15, 11341-11357 (2007).	
	Discussion and additional contributions (30 minutes)	

(3) 7/29 3:30 pm - 5 pm **Simulations I (Joint with WG2)**

WG1-7	**Electro-Optic Shock Generation in Laser Wakefield Accelerators (20 minutes)** The electron sheath surrounding the cavitation region in a blowout laser wakefield emits electro-optic shock radiation. The radiation is at the second harmonic of the pump and is emitted into a Cherenkov type angle. We present an analysis that relates the radiation characteristics to the form of the plasma bubble, and compare with three dimensional particle-in-cell simulations. Preliminary experimental results will also be presented. This unique form of radiation might be an interesting diagnostic tool for laser wakefield accelerators.	Daniel Gordon (NRL)
WG1-8	**Self-Guiding of Ultrashort Relativistically Intense Laser Pulses to the Limit of Nonlinear Pump Depletion (20 minutes)** A study of self-guiding of ultra short, relativistically intense laser pulses is presented. Here, the laser pulse length is on the order of the nonlinear plasma wavelength and the normalized vector potential is greater than one. Self-guiding of ultrashort laser pulses over tens of Rayliegh lengths is possible when driving a highly nonlinear wake. In this case, self-guiding is limited by nonlinear pump depletion(1). Erosion of the pulse due to diffraction at the head of the laser pulse is minimized for spot sizes close to the blow-out radius(2). This is due to the slowing of the group velocity of the photons at the head of the laser pulse. Using an approximately 10TW Ti:Sapphire laser with a pulse length of approximately 50fs, experimental results are presented showing self-guiding over lengths exceeding 30 Rayliegh lengths in various length Helium gas jets. Fully explicit 3D PIC simulations supporting the experimental results are also presented. 1. C.D. Decker, W.B. Mori, K.C. Tzeng, and T Katsouleas, Phys. Plasmas 3, 1360 (1996) 2. W. Lu, C. Huang, M. Zhou, and M.	Joseph Ralph (UCLA)

	Tzoufras, F. S. Tsung, W. B. Mori, and T. Katsouleas, Phys. Plasmas 13, 056709 (2006)	
WG1-9	**Laser-driven coherent betatron oscillation in a laser-wakefield cavity (10 minutes)** The origin of the disparity of emittance in and out of the plane of polarization in the bubble regime is explained in terms of coherent betatron oscillations driven by the laser field. As trapped electrons accelerate, they move forward in the bubble, ultimately interacting with the laser pulse, and this drives betatron oscillation. A simple model expresses this interaction in terms of a harmonic oscillator with a driving force from the laser and the restoring force of the static electric field of the laser wakefield bubble. The resulting beam oscillations, with period approximately the wavelength of the driving laser pulse, in the polarization plane lead to larger emittance in that plane as well as microbunching of the beam. These effects are seen directly in 3D particle in cell (PIC) simulations.	Karoly Nemeth (Accelerator Systems Division, Argonne National Laboratory)
WG1-10	**Timing and Energy Stability in a Laser Wakefield Accelerator with External Injection (10 minutes)** One of the most compelling reasons to use external injection of electrons into a laser wakefield accelerator is to improve the stability and reproducibility of the accelerated electrons. We have built a simulation tool based on particle tracking to investigate the expected output parameters. Specifically, we are simulating the variations in energy and bunch charge under the influence of variations in laser power and timing jitter. In these simulations a a0=0.2 to a0=1 laser pulse with 10% shot-to-shot energy fluctuation is focused into a plasma waveguide with a density of 1* 10^24 m^-3 and a calculated matched spot size of 50 * 10^-6 m. The timing of the injected electron bunch with respect to the laser pulse is varied from 1 ps in front of the laser pulse to 1 ps behind the laser pulse. The simulation method and first results.	G.J.H. Brussaard (Eindhoven University of Technology)
	Discussion and additional contributions (30 minutes)	

Wednesday

(4) 7/30 10:30 am - 12 pm **Stability**

WG1-11	**One Percent Energy Spread of 200 MeV LWFA Electron Beams Measured With A High-Resolution Imaging Spectrometer (20 minutes)** Monoenergetic electron beams in the energy range of 100-200 MeV have been generated by controlled injection through the counter-propagating laser pulse scheme using the 50 TW, 30 fs TiSa laser of the LOA. The energy spectrum of these electrons has been measured with a high-resolution imaging spectrometer. This spectrometer was developed to measure the energy-spectrum with higher accuracy than before - less than 1% over a broad energy range. It consists of a quadrupole electromagnet triplet followed by one permanent dipole magnet, and two scintillator screens imaged separately by CCD cameras. The electron beam propagates in vacuum from the plasma up to the scintillator screens. The resulting spectrum is then measured in different energy ranges by tuning the fields of the quadrupole magnets in accordance with each main beam energy. Very narrow spectra around almost 200 MeV with less than 1% energy spread beam have been observed.	Ahmed Benismail (LOA)
WG1-12	**Quasi-mono-energetic relativistic electron beams at 500 Hz (20 minutes)** Experiments are described which investigate the generation of relativistic electron beams using a high repetition rate laser system. A 0.1 TW laser operating at 500 Hz is incident onto a solid target at intensities up to 3 x 10^18 W/cm^2. When very short density scalelength conditions are obtained, the spectrum of electrons observed is very reproducible and is characterized by a highly non-Maxwellian "quasi-monoenergetic" energy spectrum. The spectrum and the narrow angular distribution agree well with simulations of the interaction. This electron source may be useful as a source of relativistic electrons for injection into subsequent plasma accelaeration stages.	Karl Krushelnick (Michigan)
WG1-13	**Contrast Enhancement of LOASIS CPA Laser System and Effects on Electron Beam Performance of LWFA (10 minutes)** A laser pulse contrast improvement technique based on crossed wave polarization filtering [1] has been implemented to control pre-ionization and improve the laser-plasma accelerator performance. As the evaluation of our previous experiments predicted, optical pre-pulses [inherent in most Chirped Pulse Amplification (CPA) laser systems] have strong effect on the stability of the laser accelerator and the yield of emitted THz radiation. Therefore, we were motivated to install a cross polarized wave (XPW) based technique to improve the contrast of the laser pulses. The method is based on cubic anisotropy induced by intense light pulses in special nonlinear crystals, such as BaF2 with high third order non-diagonal coefficients. Placing the nonlinear crystal between crossed polarizers, the relatively small pre-pulses and pedestal do not create enough induced anisotropy, and basically suppressed by the second polarizer, unlike the main pulse, which induces strong enough crossed polarization generation for itself, and reaches high level of transmission. The contrast enhancement factor at different time regions before the arrival of the main pulse has been measured with a commercial third-order cross-correlator device (Sequoia, Amplitude Technologies Inc.). The summary of the main laser beam parameters measured after the installation of the XPW filter are: - input/output energy to/from XPW filter: 250-300 uJ/ 30-70 uJ. - input/output optical spectrum FWHM at XPW filter: 46 nm/53 nm. - contrast enhancement: from 10-7 to 10-10 for the pedestal, and from 10-4 to 10-8 for the prepulses at -5 ps time delay. A detailed parameter-scan experiments was done with the contrast-enhanced	Csaba Toth (LBNL)

	laser to gauge the effectiveness of increasing the pulse contrast on the performance of the accelerator and the production of THz and other radiations. The results show not only a dramatic increase in the production of charge, THz, gamma and neutron yields, but also a dramatic decrease in shot-to-shot variability, which were at the 100% level prior to XPW implementation, and are now roughly at the 10% level. [1] A. Jullien, O. Albert, F. Burgy, G. Hamoniaux, J. Rousseau, J. Chambaret, F. Auge-Rochereau, G. Cheriaux J. Etchepare, N. Minkovski, and S. M. Saltiel, Opt. Lett. 30, 920 (2005).	
WG1-14	**Pointing stability improvement with miniature quadrupole lenses for laser-wakefield accelerated electrons (LWFA) (10 minutes)** After having successfully tested our miniature quadrupole lenses at the conventional accelerator "MaMi" (Mainzer Mikrotron, Mainz, Germany), the next step was to use them at the Max-Planck-Institute for Quantum Optics (MPQ, Garching, Germany) with laser-wakefield accelerated (LWFA) electrons. These electrons were accelerated by the ATLAS laser system (1J, 35fs) in a very stable manner up to 200 MeV. The setup consists of novel permanent magnet miniature quadrupole (PMQ) lenses each with a radius of just 6 mm, a length of less than 2 cm and a field gradient on the order of 500 T/m. While the goal at the conventional accelerator, where all the parameters are well known and finely adjustable, was to produce a micrometer focus, the goal of the latter experiment was to demonstrate the transport and focusing of LWFA electrons. Therefore, two schemes of lens configurations were chosen, one for a collimated electron beam and the other to show an energy resolved focus, which means a focus at the electron spectrometer. A significant reduction of both, the beam size as well as the pointing has been shown in a very reproducible and predictable way. These experiments pave the way for a controllable beam transport and are essential for future applications. Due to their small size, they go along with the size reduction of the LWFA accelerators and are perfectly suited for applications such as table-top undulators and eventually table-top free-electron lasers.	Matthias Fuchs (University of Munich)
	Discussion and additional contributions (30 minutes)	

(5) 7/30 1:30 pm - 3 pm **Guiding**

WG1-15	**Resonant plasma wave excitation by laser wakefield inside capillary tubes (20 minutes)** In the linear regime or moderately non-linear regime of laser wakefield accelerator, accelerating electric fields are of the order 10 GV per meter, and relativistic electrons injected into the wave can acquire an energy of the order of one GeV over a length of a few centimeters. The control of the characteristics of the accelerating plasma wave is crucial for achieving a usable laser-plasma accelerator stage. The present limitation for the energy of accelerated electrons in the standard LWFA is due to the small acceleration distance, limited to a few Rayleigh lengths, typically of the order of one millimeter. The extended propagation of a laser pulse over many Rayleigh lengths can be achieved by the use of waveguides, such as plasma channels and capillary tubes. The main objective of our current work is to demonstrate experimentally the excitation, in the weakly non linear regime, of a plasma wave in the wake of an intense laser beam guided in a capillary tube over several centimeters. An experiment has been performed using the TeraWatt Ti:Sa laser at the Lund Laser Center. Capillary tubes with lengths up	Brigitte Cros (LPGP, CNRS – Universite Paris Sud)

	to 8cm have been used to guide the laser beam with high coupling efficiency. The spectrum of the short laser pulse was measured at the output of the capillary tube. Large red-shifts of the fundamental laser spectrum have been observed. Comparison with numerical modelling confirms the production of high accelerating field.	
WG1-16	**Injection in a capillary-discharge waveguide using an embedded gas jet (10 minutes)** The capillary-discharge laser-guided LWFA at LBNL can produce energetic electron beams for a wide range of laser and plasma parameters. The dependence of the properties of these beams on laser pulse length, laser energy, and plasma density are presented, as well as the associated laser pump depletion and spectral shifts.	Anthony Gonsalves (LBNL)
WG1-17	**Performance Analysis of Capillary Discharge Guided Laser Plasma Accelerator (10 minutes)** A GeV-class laser-driven plasma-based wakefield accelerator has been realized at the Lawrence Berkeley National Laboratory (LBNL). This accelerator can provide electron beams with wide range of properties depending on input laser and plasma parameters. In this talk, the effect of laser-discharge delay and laser pointing on both the electron beam and output laser beam properties will be discussed.	Kei Nakamura (LBNL)
WG1-18	**Generation and application of slow wave plasma guiding structures to direct laser acceleration (10 minutes)** We report progress towards the application of corrugated plasma waveguides[1] to THz generation[2] and direct electron acceleration[3]. We produce exceptionally stable plasma waveguides with adjustable axial modulation periods as short as 70 microns, where the period can be significantly smaller than the waveguide diameter. These waveguides are \`slow wave' guiding structures capable of supporting intense pulses with sub-light phase velocities, with application to direct laser acceleration of charged particles and phase-matched generation of a wide spectrum of electromagnetic radiation [1]. We have measured guided propagation in these guides at intensities up to ~2x10**17 W/cm**2, limited only by our current laser energy. Unmodulated waveguides were initially generated using lowest order (J0) Bessel beam pulses produced by an axicon-focused (Bessel) beam from a 10Hz, 1064 nm, 100ps Nd:YAG laser with pulse energy of 150-500 mJ. The initial cluster source in these experiments was a cryogenically cooled supersonic gas jet (H_2, Ar, N_2) with a 1.5 cm long by 1 mm wide nozzle exit orifice. The line-focus of the Bessel beam overfilled the 1.5 cm length of the cluster jet, resulting in 1.5 cm long plasma channels. Channels up to 3 cm in length were obtained using longer jets. A transmissive \`ring grating' (RG) system centered in the path of the Nd:YAG laser pulse allows us to generate periodically modulated waveguides. The axicon axially projects onto its line focus the diffraction pattern produced by the RG, leading to periodic axial intensity modulations of the Bessel beam. This causes axial modulation in the heating of the cluster jet, producing periodic axial variation in the channel-forming plasma. This plasma subsequently undergoes axially periodic radial hydrodynamic shock expansion, producing a corrugated plasma waveguide. Using RGs we have been able to exert a high degree of control over the channel modulation depth and period. The modulations, as short as 70μm, are durable, highly reproducible, and still observable after at least 8 ns of plasma channel expansion. Channels with longer period modulations have also been generated which allow the leakage and propagation effects of the guided pulse to be observed. These corrugated waveguides make high-field direct acceleration of electrons possible [3]. By controlling the corrugation period we can quasi-phase match a properly phased bunch of electrons and the z-component of an appropriate injected and guided laser pulse. As the pulse passes through the modulations, periodic variations in plasma density break the symmetry between the field	B. Layer (Maryland)

	oscillations and net acceleration occurs, in contrast to perfectly canceling acceleration and deceleration, as would occur in a straight waveguide. [1] B.D. Layer et. al., Phys. Rev. Lett. 99, 035001 (2007) [2] T. M. Antonsen Jr., J. Palastro and H. M. Milchberg, Phys. Plasmas 14, 033107 (2007). [3] A. York et. al., Phys. Rev. Lett. 100, 195001 (2008); J. Palastro et al., Phys. Rev. E 77 036405 (2008).	
WG1-19	**Direct Acceleration of Electrons in a Corrugated Plasma Waveguide (10 minutes)** Direct laser acceleration of electrons provides a low power tabletop alternative to laser wakefield accelerators. Until recently, however, direct acceleration has been limited by diffraction, phase matching, and material damage thresholds. The development of the corrugated plasma channel [B. Layer et al., Phys. Rev. Lett. 99, 035001 (2007)] has removed all of these limitations and promises to allow direct acceleration of electrons over many centimeters at high gradients using femtosecond lasers [A. G. York et al, Phys Rev. Lett 100, 195001 (2008), J. P. Palastro et al., Phys. Rev. E 77, 036405 (2008)]. We present a simple analytic model of laser propagation in a corrugated plasma channel and examine the laser-electron beam interaction. Simulations show accelerating gradients of several hundred MeV/cm for laser powers much lower than required by standard laser wakefield schemes. In addition, the laser provides a transverse force that confines the high energy electrons on axis, while expelling low energy electrons.	J. P. Palastro* (LLNL, Maryland)
	Discussion and additional contributions (30 minutes)	

Thursday

(6) 7/31 10:30 am - 12 pm **Staging and injection**

WG1-20	**Two staged laser wake-field acceleration with transient plasma micro-optics; towards repeatable generation of quasi -mono energetic electron beam with excellent emittance. (20 minutes)** We present two-staged laser wake-field acceleration with a transient plasma micro-optics in a high-density gas-jet. We have ever demonstrated generation of repeatable electron beams with excellent emittance and with big charge of ~ nC by laser wake-field acceleration under external static magnetic field of ~ 0.2T [1]. However the energy spectra of the beams exhibited Maxwell-like distribution in this scheme. As a next step of the study, we improve this thermal energy spectrum to a quasi-monoenergetic one with keeping excellent emittance, big charge and its repeatability. Very recently it is found that a transient plasma micro-optics produced by co-propagating laser pulses in a high-density gas-jet under stronger external magnetic field may provide the solution for that. We are going to present the latest experimental results in the workshop. [1] T.Hosokai, et.al., Phys. Rev. Lett. 97, 075004 (2006)	Tomonao Hosokai (Department of Energy Sciences, Tokyo Insttute of Technology)
WG1-21	**Observation of large-angle quasi-monoenergetic electrons from a laser wakefield (20 minutes)** A relativistically intense laser pulse is focused into a gas jet and quasi-monoenergetic electrons emitted at a 40 degree angle with respect to the laser axis are observed. The average energy of the electrons was between 1 and 2 MeV and the total accelerated charge was about 1 nC emitted into a 10 degree cone angle. The electron characteristics were sensitive to plasma density. The results are compared with three dimensional particle-in-cell simulations. This electron acceleration mechanism might be useful as a source of injection electrons in a laser wakefield accelerator.	Dmitri Kaganovich (NRL)
WG1-22	**Stable & fully tunable source of quasi-monoenergetic electrons generated by a laser-plasma accelerator (10 minutes)** A previous experiment [1] has shown that the use of two colliding pulses in a collinear geometry can produce a stable source of electrons that is also easily tunable in energy . We report here the result of a recent experiment with two laser beams colliding with an angle, thus having the advantage of protecting the laser system from any feedback. It not only confirms those earlier results but also proves that the charge and energy spread of the beam are also controlable independently of its energy. Phase space volume of the injected particles can indeed be shrinked independently of the main accelerating structure, by changing the intensity or the polarization of the injection pulse. Charge can therefore be controlled together with the energy spread of the beam. Energy spread of the beam can also be reduced by changing the ratio between injection phase width and plasma wavelength. The good agreement between PIC simulations and experimental observations indicates that all the physical processes are well understood. This first stable and fully tunable source is a major step towards a usable source of electrons generated by laser-plasma accelerators and for the design of future accelerators. The first application of this source has been the fine characterization of the electron spectrum with a high resolution spectrometer. [1] J. Faure, C. Rechatin, A. Norlin, A. Lifschitz, and V. Malka. Nature, 444:737, 2006.	C. Rechatin (LOA)
WG1-23	**Staging Laser Plasma Accelerators for Increased Beam Energy (10 minutes)** Staging laser plasma accelerators is an efficient way of mitigating laser pump depletion in laser driven accelerators and necessary for reaching high energies with compact laser systems. The concept of	Dmitriy Panasenko (LBNL)

	staging includes transporting the electron beam from one accelerating module to the other, incoupling additional laser energy, and dumping the residual laser beam from the previous stage. Incoupling laser energy with conventional optics will require increasing distance between the accelerating modules to ~10m scale resulting in decreased accelerating gradient and complicated e-beam transport. In this presentation we will discuss several alternative proposals aimed at preserving the acceleration gradient and quality of the electron beam.	
	Discussion and additional contributions (30 minutes)	

(7) 7/31 1:30 pm - 3 pm **Radiation generation (joint with WG 6)**

WG1-24	**Compact Radiation source based on laser-plasma wakefield accelerator (25 minutes)** Radiation sources are ubiquitous tools for studying the structure and dynamics of matter. Current light sources can produce both brilliant and picosecond duration x-ray pulses which are useful for time resolved studies. There is a drive to reduce their pulse durations to a few femtoseconds or less, and increase their brilliance to enable single-shot measurements for unravelling structural or chemical changes on unprecedented time scales. Synchrotron source provide high average power and tuneable x-ray radiation, whereas the next generation x-ray free-electron lasers (FELs), which are currently being developed, will provide intense coherent radiation with several tens of femtosecond pulse durations. However, these sources are some of the largest instruments that exist. Their huge size and cost is a result of the microwave accelerator technology on which they are based. The acceleration gradients are restricted to gradients of 10?100 MV/m. The recent development of table-top multi-terawatt femtosecond lasers has provided the opportunity to significantly miniaturise accelerator technology by harnessing plasma waves as a medium for generating electrostatic fields with gradients approaching 1 TV/m. Recent pioneering developments in laser-driven plasma wakefield accelerators has resulted in controllable high quality electron bunches that are providing a realistic prospect of realising a table-top synchrotron source and possibly an X-ray FEL. This could transform the way science is done by making available compact femtosecond duration sources of infrared, UV and X-ray sources to University sized establishments. We will present the significant challenges facing the realisation of a compact plasma based source and review the first major advance where synchrotron radiation from an undulator driven by wakefield accelerator was demonstrated. Recent progress towards an FEL based on a plasma wakefield accelerator and results from the ALPHA-X project will be presented. We will also show how compact undulator radiation can be used to measure the energy spread of a high energy electron beam.	Dino Jaroszynski (University of Strathclyde)
WG1-25	**Free-electron laser driven by the LBNL laser-plasma accelerator (15 minutes)** In this talk I will present a design for a compact free-electron laser (FEL) source of ultra-fast, high-peak flux, EUV pulses employing a high-current, GeV electron beam from the existing LBNL laser-plasma accelerator. The proposed ultra-fast source would be intrinsically temporally synchronized to the drive laser pulse, enabling pump-probe studies in ultra-fast science with pulse lengths of tens of fs. Owing to the high current (>10 kA) of the laser-plasma-accelerated electron beams, saturated output fluxes are potentially greater than 1E13 photons/pulse. I will discuss devices based both on SASE and high harmonic generated input seeds to reduce undulator length and fluctuations. Numerical results for the expected FEL performance using current laser-	Carl B. Schroeder (LBNL)

	plasma-accelerator beam parameters are presented. The impact of longitudinal wakefields from the high-current beam in the undulator vacuum chamber and electron beam energy chirps from space-charge forces during transport to the undulator are examined. Initial experiments will focus on generation of spontaneous undulator radiation, and beam diagnostics based on spontaneous undulator radiation will also be discussed.	
WG1-26	**Polarized γ source based on Compton backscattering in a laser cavity (15 minutes)** We propose a novel gamma source suitable for generating a polarized positron beam for the next generation of electron-positron colliders, such as the International Linear Collider (ILC), the Compact Linear Collider (CLIC), and SuperB. This 30-MeV polarized gamma source is based on Compton scattering inside a picosecond CO2 laser cavity generated from electron bunches produced by a 4-GeV linac. We identified and experimentally verified the optimum conditions for obtaining at least one gamma photon per electron. After multiplication at several consecutive interaction points, the circularly polarized gamma rays are stopped on a target, thereby creating copious numbers of polarized positrons. We address the practicality of having an intracavity Compton-polarized positron source as the injector for these new colliders.	V. Yakimenko (Brookhaven)
WG1-27	**EUV X-ray and electron generation by colliding laser pulses (15 minutes)** Using counter-crossing laser pulses we have investigated light reflection from moving electron density modulation (flying mirror) driven by ultra-intense laser pulses. When the appropriate colliding of two laser pulses was achieved we observed reflected photons frequency of which was 50-110 times higher than initial one. Using the same setup, we made optical injection of electrons into wakefield. The stability of electron generation and quality were improved. Recently, we have conducted flying mirror and optical injection using the complete counter propagating setup. The results will be presented at the workshop	Masaki Kando (JAEA)
WG1-28	**Space-charge effects in electron bunches generated by laser-plasma accelerators and their impact on table-top FELs (10 minutes)** Recent advances in laser-plasma accelerators, including the generation of GeV-scale electron bunches, enable applications such as driving a compact free-electron-laser (FEL). Significant reduction in size of the FEL is facilitated by the expected ultra-high peak beam currents (10--100~kA) generated in laser-plasma accelerators. At low electron energies such peak currents are expected to cause large space-charge effects such as bunch expansion and induced energy variations along the bunch, hindering the FEL process. In this paper we discuss a self-consistent approach to modeling space-charge effects for the regime of laser-plasma-accelerated ultra-compact electron bunches at low or moderate energies. Analytical treatments are considered as well as point-to-point particle simulations, including the beam transport from the laser-plasma accelerator through focusing devices and the undulator. In contradiction to non-self-consistent analyses (i.e., neglecting bunch evolution), which predict a linearly growing energy chirp, we have found the energy chirp reaches a maximum and decreases thereafter. The impact of the space-charge induced chirp on FEL performance is discussed and possible solutions are also presented.	Florian Gruener (MPQ)
WG1-29	**Status of Coherent Cherenkov Wakefield Experiment at UCLA (10 minutes)** 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	Alan Cook (UCLA)

	(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.	

(8) 7/31 3:30 pm - 5 pm **Diagnostic Techniques**

WG1-30	**Overview of laser-plasma acceleration experiments at the University of Texas (20 minutes)** At the University of Texas we recently installed a new 45 TW, 25 fs, 10 Hz ultra-high contrast Ti:S laser system, and achieved first operation of the 1.25 PW, 150 fs Texas Petawatt (TPW) laser system [1]. I will present an overview of three lines of laser-plasma acceleration experiments in progress with these laser systems: (1) Single-shot visualization of laser-plasma accelerator structures. Previously we presented snapshots of laser wakefields acquired by frequency-domain holography (FDH) [2]. I will present new results showing signatures of relativistic laser-plasma nonlinearities as well as wake structure in FDH data. In addition we are developing generalizations of FDH in which probe-reference pulse pairs propagate noncollinearly with the driving pulse, potentially enabling tomographic reconstruction of both the quasi-static structure and longitudinal evolution of the plasma wake. (2) Laser-driven acceleration in clustered plasmas. Dephasing of accelerated electrons from a laser-driven wakefield limits acceleration length and energy gain in dense plasmas (ne ~ 10^18 cm-3). We propose increasing dephasing length by manipulating the group velocity of the drive pulse using clusters. I will present experimental results [3] showing that by pre-expanding clusters with an ionization/heating pulse and optimizing cluster/monomer ratio, the group velocity of a mildly relativistic trailing drive pulse can become equal to c. 3) Wakefield acceleration driven by the TPW Laser. The TPW laser enables near-resonant laser wakefield acceleration in plasma of density 5 x 10^16 < ne < 10^17 cm^-3 with a focused spot (w0 ~ 100 μm) greater than a plasma wavelength. I will present simulations by S. Kalmykov showing that the TPW pulse self-guides for up to 10 cm under these conditions and generates up to 7 GeV electrons. I will describe the experimental set-up under construction. Further details of this work will be presented in accompanying posters. [1] E. W. Gaul et al., submitted to Opt. Lett. (2008). [2] N. H. Matlis et al., Nature Phys. 2, 749 (2006); A. Maksimchuk et al., Phys. Plasmas 15, 156703 (2008). [3] B. Shim et al., Phys. Rev. Lett. 98, 123902 (2007). [4] S. Kalmykov et al., Phys. Plasmas 13, 113102 (2006).	Mike Downer (UTexas)
WG1-31	**Indication of laser pump depletion via the imaged spectrum of self-guided laser light through an underdense plasma (20 minutes)** In recent experiments at UCLA it has been shown that an ultra short laser pulse (FWHM~50 fs), with an initial ao ~ 2, can be self guided over tens of Rayleigh lengths in an underdense plasma [1]. In these experiments the plasma density was varied between 4x1018 cm-3 to 1x1019 cm-3. Using an imaging spectrograph the frequency of the transmitted laser pulse was spatially and spectrally resolved at the exit of 3, 5 and 8 mm long plasmas. The frequency of the transmitted laser pulse was spectrally modulated by the density gradient of the plasma wave that it creates. The self generated plasma wave also creates an appropriate density depression which self guides the laser. From the amount of spectral modulation the effect of laser pump depletion is inferred as either the plasma density is increased for a fixed plasma length or the plasma length is increased at a given	Arthur Pak (UCLA)

	plasma density. [1] J.E. Ralph, et. al These Proceedings Work Supported by DOE Grant DEFG02-92ER40727	
WG1-32	**High field THz pulses from a Laser Wakefield Accelerator (10 minutes)** We present generation and characterization of near single-cycle, high-field THz pulses in the uJ regime from a laser wakefield accelerator (LWFA). THz is emitted as coherent transition radiation (CTR) from the plasma-vacuum boundary at the exit of the gas jet. The THz is collected and refocused by off-axis parabolas to a test stand where a suite of diagnostics is performed, including energy measurement by a golay cell, and Electro-Optic (EO) mapping of the spatio-temporal electric field using a probe pulse split from the main laser. Pulses of ~ 0.4 ps duration, with peak fields of 0.3 MV/cm and energies of 5 - 10 uJ, were measured. The spatio-temporal electric field structure and the methodology used to recover it will be discussed, as well as the applicability of the THz pulses as an electron beam diagnostic and as a non-destructive materials probe.	Nicholas H. Matlis (LBNL)
WG1-33	**Characterization of the Injector-Accelerator Interface in a Laser Wakefield Accelerator Experiment (10 minutes)** Research is currently underway at the U.S. Naval Research Laboratory to increase electron beam energy and control by coupling an external electron injector (gas jet) with an accelerator stage (ablation capillary). In trying to establish a high quality beam, it is important to consider the plasma density gradients at the injector-accelerator interface. Preliminary studies have been completed using interferometric and Schlieren diagnostics. In addition to studying the interface, a new and novel diagnostic technique has been implemented that can completely characterize the injector. This technique utilizes a strong shockwave and can potentially be used to investigate turbulent effects near the injector-accelerator interface. Preliminary results and analysis will be presented. *This work is supported by the Department of Energy	Michael Helle (Georgetown)
	Discussion and additional contributions (30 minutes)	

Friday

(9) 8/1 10:30 am - 12 pm **Simulations II (joint with WG2)**

WG1-34	**Simulation of quasi-monoenergetic electron beams produced by colliding pulse wakefield acceleration (20 minutes)** The collision of two laser pulses can inject electrons into a wakefield accelerator, and has been found to produce stable and tuneable quasi-monoenergetic electron beams [J. Faure et al., Nature 444, 737 (2006)]. This colliding pulse scheme is studied here with 2D and 3D Particle-In-Cell simulations. The results are successfully compared with experimental data, showing the accuracy of the simulations. The mechanisms involved, such as heating during collision, wake inhibition, trapping and acceleration are presented in details. The variations of beam charge and energy with collision position in the experiment are explained: energy depends on the remaining acceleration length after the collision, whereas charge depends on the precise pump pulse characteristics when collision happens. Because of propagation effects, these characteristics evolve when the collision position is moved.	Xavier Davoine (CEA)
WG1-35	**Numerical simulations of LWFA for the next generation laser systems (20 minutes)** The development of new laser systems based on OPCPA will push Laser Wakefield Accelerators (LWFA) to a qualitatively new energy range. As in the past, numerical simulations will certainly play a critical role in testing, probing and optimizing the physical parameters and setup of these upscale experiments. Based on the prospective design parameters for the the future Vulcan 10PW OPCPA system [1], we have determined the goal parameters for a single LWFA stage from theoretical scalings [2] for such system, which predict energies at the energy frontier, with self-injected electrons in excess of 10 GeV for a self-guided configuration and above 50 GeV bunches in a laser-guided configuration. These parameters were then used as a baseline for 3D full-PIC Lorentz boosted simulations in OSIRIS[3] and 3D fast-simulations with QuickPIC[4]. A 12GeV self-injected beam was obtained with both codes, in agreement with theoretical predictions for the maximum energy gain and the injected charge. Preliminary results on the laser-guided configuration already confirm the possibility to reach the considerably higher energies predicted by the theoretical scalings. References [1] http://www.clf.rl.ac.uk/Facilities/vulcan/index.htm [2] W. Lu et al, Phys. Rev. ST Accel. Beams 10, 061301 (2007) [3] R. A. Fonseca et al, Lecture Notes in Computer Science 2329, III-342, Springer-Verlag (2002) [4] C. Huang, et al., Journal of Computational PhysicsVolume 217, Issue 2, 20 September (2006)	Samuel Martins (GoLP/IPFN - Instituto Superior Tecnico – Portugal)
WG1-36	**Scaled simulations of a 10 GeV accelerator (10 minutes)** Laser plasma accelerators are able to produce high quality electron beams from 1 Mev to 1 GeV. We now look at designing laser wakefield accelerators to reach energies from 10 GeV to 1 TeV using PetaWatt laser powers and staging. This next generation of plasma accelerator experiments will use a two-stage approach where a high quality electron bunch is first produced and then injected into an accelerating stage functioning in the quasi-linear regime. In this talk I will present scaled particle-in-cell simulations of a 10 GeV stage. Physical parameters are scaled to be able to perform these simulations at reasonable cost. Properties of the electron beam produced are determined (charge, energy, energy spread, emittance), and parameter regimes are scanned to optimize the quality of the electron bunch at the output of the stage.	Estelle Cormier-Michel (LBNL)
WG1-37	**Geometry of thermal plasma oscillations (10 minutes)** We analytically explore the role of geometry of the 1-particle distribution in fully relativistic non-linear thermal plasma	David A Burton (Lancaster)

	oscillations using the covariant Vlasov-Maxwell equations. We analyse multi-dimensional piece-wise constant (3-dimensional "water-bag"-type) distributions with smooth boundaries whose dynamical evolution is fully determined by the Vlasov-Maxwell system and an initial condition. It is shown that the exact shape of axially symmetric distributions may be encoded without approximation in one non-linear oscillator whose potential depends on the initial shape of the distribution. We discuss the influence of the distribution's shape on the behaviour of the plasma near wave-breaking.	
	Discussion and additional contributions (30 minutes)	

(10) 8/1 1:30 pm - 3 pm **Technology**

WG1-38	**Progress Towards Plasma Pulse Compression of High Energy, Long Pulse Laser Beams (20 minutes)** Compression of laser pulses to 1-10 ps duration using stimulated Raman scattering (SRS) in a plasma promises to provide unprecedented power and intensity for a variety of applications, by avoiding the limits to fluence and intensity that are needed to avoid damage to the solid state optics that are used in conventional approaches. In particular, the ability to compress pump beam pulses of approximately ns duration will allow present facilities with 10?s kJ to over a MJ of energy to produce ultra short pulses efficiently, advancing applications in; fusion by fast ignition, x-ray production of high energy density experiments, as well as laser driven particle accelerators. We will discuss a series of experiments to demonstrate the needed beam amplification rate, and focal spot quality in a < 3mm plasma with the properties needed for compression of these pulses (ne ~ 10^19/cm3, Te 200 to 300 eV) when the plasma is extended. The experiments use He plasmas produced with a 300 J, 1 ns, beam at the Jupiter Laser facility to amplify a counter-propagating, ultra-short pulse (USP) seed by a factor of 10x to 37x and study the dependence of the amplification, the associated non-linear wave response, and the resulting beam quality and energy, on the intensity of both seed and pump beam. In particular a regime in which amplification of USP beams is achieved while maintaining a low angular divergence of the beam consistent with good focal spot quality will be discussed. This work was performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract No. DE-AC52-07NA27344. UCRL-CONF-405197	Robert Kirkwood (LLNL)
WG1-39	**Raman amplification in plasma: a tool for laser-plasma acceleration (10 minutes)** Raman amplification in plasma is a possible future source of ultraintense, ultrashort laser pulses [1]. Although such sources will have uses across a wide range of science and technology applications, it should be of particular interest to the laser-plasma accelerator community, who already have much of the skills and equipment necessary to exploit this technique. This work provides an introduction to Raman amplification in plasma and will present an overview of the current state of the field, including the current limitations and potential barriers to realising this method as a useful tool. Also presented will be the current theoretical and experimental works being undertaken at the University of Strathclyde, UK. Briefly, a short, low intensity seed pulse can be amplified at the expense of a long counterpropagating pump beam, coupled through the motion of the plasma electrons. This is achieved by choosing the detuning between pump and probe, such that the beat of the two laser pulses excites a plasma wave through the ponderomotive force which scatters photons from the pump to the probe. The counterpropagating geometry allows the seed to grow to intensities greater than that of the pump [2]. The advantage of this scheme over	John Farmer (Strathclyde)

	conventional optical amplifiers is the significant reduction in both the size and cost of the system. As there is no damage threshold for plasma, the seed pulse does not need to be stretched before amplification and subsequently recompressed, as in Chirped Pulse Amplification, removing the need for compression gratings which can become large and expensive at high intensities. Recent experiments have have shown energy transfer efficiencies from pump to probe of 7% in mm scale plasma lengths [2], with significant improvements on this figure expected from our own experimental programme. Our current theoretical work investigates the role of thermal effects in Raman amplification. This includes losses due to collisional and Landau damping and how heating will alter the resonance conditions of the interaction through the Bohm-Gross shift. We show the effect that these will have on the evolution of the seed pulse as it is amplified. [1] G. Shvets et al, Phys. Rev. Lett. 81 4879 (1998) [2] J. Ren et al, Nat. Phys. 3 732 (2007)	
WG1-40	**Radiation protection issues with Petawatt lasers: a numerical perspective (10 minutes)** Laser radiation shining on a plasma can excite very large electrostatic fields, resulting in the acceleration of copious amounts of energetic, multi-MeV particles from the target. In a low-density plasma, electrons can be efficiently accelerated into a collimated beam at relativistic energy by the high-frequency electrostatic fields excited in the wake of a short laser pulse. Closer to the critical density, the energetic electron flux becomes more isotropic and may carry away a larger fraction of the incident laser energy. This energetic electron flux can be converted into x-rays by Bremsstrahlung emission in a conversion target with high atomic number. Specific numerical codes are developed in our group to study these phenomena. The multidimensional, relativistic Particle-In-Cell code CALDER is used to model laser?plasma interaction and particle acceleration. In a second step, CALDER results are coupled to Monte Carlo codes to compute particle transport through secondary targets and induced radiation. The validity of this numerical procedure will first be checked by modelling a recent experiment on the Alise laser at CEA/CESTA, during which the x-ray source characteristics were measured with activation, dose and imaging diagnostics. For higher laser energy and power, photon energies and dose levels increase and radiological safety becomes a concern. In a second part, the cases of future PW facilities such as PETAL at CESTA and the 10 PW project at RAL will be examined in this respect.	Erik Lefebvre (CEA)
WG1-41	**Overview of the Ultra-intense Laser Applications to the Industries at GPI (10 minutes)** The laser accelerator provides us not only the ultra high fields, but also the extremely short pulse radiation sources. Using a table-top Ti:sapphire laser, we are pursuing the activities of the laser for the industrial application: first on the backward vision of distant objects, second on illumination of the spores and third on the ultra short beat-wave accelerator development for the economical radiation sources. 1. Backward see-through vision of distant objects using the ultra-intense laser-produced X-rays Safeties of the public transport facilities, such as the air-port or sea-port buildings, are the big problems of the national or homeland securities. Hence the remote and see-through imaging becomes the urgent issue, but not yet such a technique is realized, because the natural radiation in an ordinary environment is too much to obtain the sufficient backscattered signals so far. The idea of the backward see-through imaging is that the lower the Z number and the deeper the thickness of the object material, the scattering becomes more. A 1.2TW table-top CPA laser, 800 nm in wavelength, 150 fs in pulse width and 62 mJ in energy is focused by an off-axial parabola on a 0.5 mm-thick aluminum target in a vacuum chamber, generating the Bremsstrahlung X-rays of from 20 to 100 keV in picosecond	Yoneyoshi Kitagawa (The Graduate School for the Creation of New Photonics Industries, Nishi-ku, Hamamatsu 431-1202, Japan)

	interval. The coincident measurement with the primary X-rays enable us to distinguish the material differences between various objects, that is, acrylic, copper and lead blocks inside an aluminum container. The scattering materials modified the energy spectra of the backscattered X-rays, which further confirmed us to identify the scattering object materials. The achievement here is an important step towards the homeland security, the disaster relief and so on. 2. Short plse laser produced X-rays illumination on spores. Extremely short and intense laser pulse produced X-rays, as seen in the above paragraph, are first illuminated on Aspergillus awamori. Only ten Gy intensity or 10^4 shots illumination killed 99.9 % spores. While, so weak illumination as 10m Gy or that of only 10 shots yielded more than 10 times germination. The latter phenomenon has been shown using the current cw high voltage radiation source, but it is only 1.2 times or less. By using the current cw source, we have calibrated the illumination intensity on the spore. The results seem to prove useful for the cancer therapy. 3. Acceleration of Cone-Produced Electrons by Double-Line Ti-Sapphire Laser Beating We demonstrate acceleration and stochastic heating of electrons in a beat wave scheme using a short-pulse(150fs) double-line Ti-Sapphire laser. The laser beat wave produces a resonant relativistic plasma wave of field intensity 16 GV/m in a hydrogen plasma of density 5 x 10^18 /cm^-3. To inject electrons, we use a plane-gas hybrid target, where the cone-produced electrons are accelerated in the adjustment gas jet via the resonant plasma wave, increasing their slope temperature from 0.05 MeV to 0.15 MeV. A one-dimensional particle-in-cell simulation and a stochastic acceleration model confirm the slope temperature increase.	
WG1-42	**A fast, electromagnetically driven supersonic gas jet target for laser wakefield acceleration (10 minutes)** Laser-Wakefield acceleration (LWFA) promises electron accelerators with unprecedented electric field gradients. Gas jets and gas-filled capillary discharge waveguides are two primary targets of choice for LWFA. Present gas jets have lengths of only 2-4 mm at densities of 1-4x1019 /cm3, sufficient for self trapping and acceleration to energies up to ~150 MeV. While 3 cm capillary structures have been used to accelerate beams up to 1 GeV, gas jets require a well collimated beam that is ?10 mm in length and 10Hz) operation, return spring non-linearity and materials selection for various components. Optimization of the valve dynamics and preliminary designs of the supersonic flow patterns are described. * This research is supported by DOE Grant # DE-FG02-08ER85030 and by AASC internal funds.	Mahadevan Krishnan (Alameda Applied Sciences Corp.)
	Discussion and additional contributions (30 minutes)	