Working Group 4:

Beam-Driven Acceleration

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Abstract Index

Name of submitting author	Dr. Erik Adli
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Abstract Title	**Transverse effects in plasma-wakefield acceleration at FACET**
Author/Affiliation listing	**E. Adli** (University of Oslo and SLAC), M. Hogan (SLAC), P. Muggli (MPI of Physics), W. An, W. Mori (UCLA)
Abstract	We investigate transverse effects in the plasma-wakefield acceleration experiments planned and ongoing at FACET. We use PIC simulation tools (mainly QuickPIC) to simulate the interaction of the drive electron beam and the plasma. We present correlations of simulation results with FACET early experimental results.
Summary	
We investigate transverse effects in the plasma-wakefield acceleration experiments planned and ongoing at FACET. We use PIC simulation tools (mainly QuickPIC) to simulate the interaction of the drive electron beam and the plasma. In FACET a number of beam dynamics knobs, including dispersion and bunch length knobs, can be used to vary the beam transverse characteristics in the plasma. We present correlations of simulation results with FACET early experimental results.	

Name of submitting author	Dr. Chris Clayton
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Abstract Title	**Pulse-discharge plasmas for plasma-accelerator applications**
Author/Affiliation listing	**C. E. Clayton** and C. Joshi/ UCLA, Department of Electrical Engineering N. C. Lopes/ GLP, Instituto Superior Técnico, Lisbon
Abstract	For particle-beam-driven plasma wakefield accelerators, a long and fully-ionized plasma is desirable. We describe an experiment at UCLA to develop a prototype of such plasma using a pulsed-current discharge.
Summary	
For particle-beam-driven plasma wakefield accelerators, a long and fully-ionized plasma is desirable. We describe an experiment at UCLA to develop a prototype of such plasma using a pulsed-current discharge. Scaling of the plasma density with glass-tube diameter and with discharge-circuit parameters is currently underway. We have found that 4 Torr of Argon can be fully ionized to a density of about 1.3e17 cm^-3 when the current density in the 1 inch diameter, 1.2 meter-long tube is around 2 kA/cm^2, at least at one point along the discharge. The homogeneity of the plasma density in the longitudinal direction is crucial to prevent slippage of the driven plasma structures with the particles. Equally important are the transverse gradients since any dipole asymmetry in the transverse direction can lead to "steering" of the particle beam.[1] The longitudinal and transverse gradients may be a function of time into the discharge, the shape of the electrodes, the tube size, and the fractional ionization for a given fill pressure. Preliminary results from such studies will be presented. The work was supported by DOE grant DE-FG02-92ER40727 and NSF grant PHY-0936266. [1] P. Muggli, et al. Nature, Vol. 411, p. 43, May (2001).	

Name of submitting author	Dr. Manoel Conde
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Abstract Title	**The Upgraded Argonne Wakefield Accelerator Facility (AWA): a Test-Bed for the Development of High Gradient Accelerating Structures and Wakefield Measurements**
Author/Affiliation listing	**M.E. Conde,** S. Antipov, D.S. Doran, W. Gai, C. Jing, R. Konecny, W. Liu, J.G. Power, E. Wisniewski, Z. Yusof Argonne National Laboratory Euclid Techlabs Illinois Institute of Technology
Abstract	The AWA Facility is undergoing a major upgrade to enable it to achieve accelerating gradients of hundreds of MV/m and energy gain of 100 MeV per structure. High charge bunches will drive wakefields in the microwave range of frequencies (8 to 26 GHz), generating RF pulses with GW power levels.
Summary	
Electron beam driven wakefield acceleration is a bona fide path to reach high gradient acceleration of electrons and positrons. With the goal of demonstrating the feasibility of this concept with realistic parameters, well beyond a proof-of-principle scenario, the AWA Facility is currently undergoing a major upgrade that will enable it to achieve accelerating gradients of hundreds of MV/m and energy gains on the order of 100 MeV per structure. A key aspect of the studies and experiments carried out at the AWA facility is the use of relatively short RF pulses (15 – 25 ns), which is believed to mitigate the risk of breakdown and structure damage. The upgraded facility will utilize long trains of high charge electron bunches to drive wakefields in the microwave range of frequencies (8 to 26 GHz), generating RF pulses with GW power levels.	

Name of submitting author	Dr. R. Joel England
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Abstract Title	**High Transformer Ratio Drive Beams for Wakefield Accelerator Studies**
Author/Affiliation listing	**J. Frederico**, M. J. Hogan, M. Litos, E. Adli, S. Gessner, Z. Wu, S. Corde / SLAC C. Joshi, W. An, W. Lu, W. Mori, G. Andonian / UCLA P. Muggli / MPQ
Abstract	For the plasma wakefield accelerator, a linearly ramped drive bunch current is predicted to enhance the transformer ratio and generate large accelerating wakes. We discuss plans and initial results for producing such bunches using the 20 GeV FACET electron beam at SLAC National Accelerator Laboratory and generating high transformer ratios.
Summary	
For wakefield based acceleration schemes, use of an asymmetric (or linearly ramped) drive bunch current profile has been predicted to enhance the transformer ratio and generate large accelerating wakes. We discuss plans and initial results for producing such bunches using the 20 GeV electron beam at the FACET facility at SLAC National Accelerator Laboratory and sending them through plasmas and dielectric tubes to generate transformer ratios greater than 2 (the limit for symmetric bunches). The scheme proposed utilizes the final FACET chicane compressor and transverse collimation to shape the longitudinal phase space of the beam. *Work supported in part by the U.S. Department of Energy under contract number DE-AC02-76SF00515	

Name of submitting author	Dr. Bernhard Hidding
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Abstract Title	**Beyond Injection: Trojan Horse Plasma Wakefield Acceleration**
Author/Affiliation listing	**B. Hidding** / UCLA Dept. of Physics and Astronomy & Heinrich-Heine-University Düsseldorf, Institute for Laser and Plasma Physics J.B. Rosenzweig, Y. Xi, B. O'Shea, S. Barber, O. Williams / UCLA Dept. of Physics and Astronomy G. Pretzler, F. Kleeschulte, T. Königstein / Heinrich-Heine-University Düsseldorf, Institute for Laser and Plasma Physics G. Andonian / UCLA & RadiaBeam Technologies P. Muggli / MPI & USC M. J. Hogan, M. Litos / SLAC D.L. Bruhwiler / Tech-X K.V. Lotov / Budker Institute of Nuclear Physics
Abstract	The recently put forward "Trojan Horse" (aka underdense/plasma photocathode) scheme is a flexible concept involving a synchronized electron bunch, ionization laser and a multi-component gas mixture. This concept allows for the first time to generate plasma-based electron bunches of higher quality than in the finest conventional accelerators.

Summary

Laser-triggered release of electrons directly within a beam-driven plasma wave paves the way to shaping ultra-compact electron bunches with unprecedented emittance [1]. In contrast to conventional injection methods, where the trajectories of background plasma electrons are altered in order to eventually achieve trapping, here the electrons are born within the plasma blowout. Electrons can be "beamed" there by a synchronized laser operating just above the ionization threshold, which for species with ionization states of about ~25 eV corresponds to a laser intensity of a0 ~ 0.02, only. The electrons produced by this underdense photocathode are easily trapped, and due to minimized transverse momentum and GV/m fields are accelerated quickly and form bunches with ultralow emittance. This concept (dubbed "Trojan Horse") is applicable to both, laser-plasma-accelerators as well as to highest-energy electron accelerators such as SLAC. Theoretic al as well as experimental investigations, as well as PIC-simulations are used in order to determine the interaction requirements and limits of both cases. Gas mixture and densities, release laser and driver bunch properties are considered with regard to how to tune the released electron bunch charge, emittance and energy. Preliminary experimental results are given for the at-threshold ionization dynamics with a 30-fs (compressible to 8-fs in a hollow fiber), few-100 μJ Ti:Sapphire laser pulse – a laser pulse obtainable by the laser system to be installed at FACET, for which we currently pre-design a proof-of-concept experiment entitled "E-210: Trojan Horse" for 2013/14.

Name of submitting author	Yong Jiang
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Abstract Title	**Design of Detuned-Cavity Two-Beam Electron Accelerator Structure**
Author/Affiliation listing	**Y.Jiang[1],** J.L. Hirshfield[2] [1]Yale University, New Haven, CT 06520, USA; [2]Omega-P, Inc, New Haven, CT 06510, USA.
Abstract	Progress has been made in the theory and simulation study, cavity design and optimization, beam dynamics analysis, beam transport design, and hardware reconstruction for an experiment to evaluate a detuned-cavity two-beam collinear electron accelerator structure.

Summary

A high-gradient two-beam electron accelerator structure is currently under development. The structure is comprised of a chain of detuned cavities disposed along the axis along which an interspersed high current drive beam and a low current test beam travel. Purposeful cavity detuning is used to provide much smaller deceleration for drive beam bunches, than acceleration for test beam bunches, i.e., to provide a high transformer ratio. Analytic theory has been modified over our earlier version [1] to include inter-cavity coupling, and structure optimization using simulation studies has been carried out. Parameters including cavity dimensions, detuning angle, cell-to-cell phase advance and inter-cavity coupling have been adjusted to optimize acceleration gradient, transformer ratio, beam-to-beam energy transfer efficiency and field flatness. The beam dynamic simulation shows no severe degradation of beam quality. An experiment to measure the transformer ratio of this structure that is being set up at Yale Beam Physics Lab will be described.

Research is supported by U.S. Department of Energy, Office of High Energy Physics.

[1] High-gradient two-beam accelerator structure, S. Yu Kazakov, S.V. Kuzikov, Y. Jiang, and J. L. Hirshfield, PRSTAB 13, 071303 (2010)

Name of submitting author	Dr. Chunguang Jing
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Abstract Title	**Applications of the Dielectric Based Accelerators**
Author/Affiliation listing	**C. Jing**, S. Antipov, P. Schoessow, and A. Kanareykin / Euclid Techlabs, LLC, 5900 Harper Rd, Solon, OH-44139. J. Power, M. Conde, W. Liu, and W. Gai / High Energy Physics Division, Argonne National Laboratory, Argonne, IL-60439. A. Zholents/ APS, Argonne National Laboratory, Argonne, IL-60439 P. Piot / Northern Illinois University, Department of Physics, DeKalb, IL 60115, USA
Abstract	Important progress on the development of dielectric based accelerators has been made experimentally and theoretically since the last workshop. Some challenges remain. We discuss the applications of dielectric structures in short pulse rf generation, high gradient accelerator, and collinear wakefield accelerator, etc.

Summary

Dielectric based accelerators offer a potential path to future high gradient accelerator machines for both HEP and FEL light source facilities. The attractiveness stems from its simplicity and high breakdown limit; particularly after the demonstration of GV/m level in the wakefield acceleration regime. Exploration into using dielectric structures in a two beam accelerator HEP collider and a collinear wakefield accelerator to drive an FEL light source have recently received much attention. Since the AAC10, progress has been made towards laying down the foundation of these conceptual designs. This talk will cover a few recent related experiments and structure development: 1. High power high frequency rf generation using dielectric based wakefield power extractors. 2. Concept and development of the short pulse (~20ns) high gradient two beam accelerator. 3. Bunch shaping and its application for dielectric collinear wakefield accelerators and FEL. The work is funded through DoE SBIR Program under Contract #DE-SC0006301, #DE-SC0004322, and DE-FG02-07ER84820.

Ref:
[1] B. Jiang, et al, Phys. Rev. ST-AB, 15, 011301 (2012).
[2] S. Antipov, et al., Phys. Rev. Lett., 108, 144801 (2012).
[3] C. Jing, et al, Proc. PAC11, 2011, pp. 2279-2281.
[4] C. Jing, et al, Proc. FLS2012.

Name of submitting author	Dr. Alexei Kanareykin
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Abstract Title	**Experimental Testing of Dielectric Based THz and Ka-band Accelerating Structures.**
Author/Affiliation listing	S. Antipov, C.Jing, **A.Kanareykin**, P. Schoessow/ Euclid Techlabs, LLC, 5900 Harper Rd, Solon, OH. W. Gai / HEP, Argonne National Laboratory, Argonne, IL. V.Yakimenko, ATF, Brookhaven National Laboratory, Upton, NY.
Abstract	We present our last year results on development and experimental high gradient testing of the dielectric based wakefield accelerating structures. The list of these dielectrics includes low loss microwave ceramic and quartz, CVD diamonds and nonlinear ferroelectrics.

Summary

In this paper we report on a group of experiments with dielectric-based accelerating structures performed laste year at the ATF (BNL), the AWA (ANL) and the FACET (SLAC). Advanced dielectric materials can sustain high surface fields and high pulsed power at GHz frequency range. CVD polycrystalline and single crystal diamonds, low loss microwave ceramic and fused silica have been considered for a dielectric based accelerating structure to study of the physical limitations encountered driving extremely high amplitude wakefields of a dielectric based accelerator. THz radiation has been previously generated for short ~10 GV/m pulse with the 100 µm diameter dielectric fiber. A THz diamond based structures tested at BNL/ATF showed no evidence of polycrystalline structure deformation after electron beam exposure. The high gradient beam test at AWA has demonstrated no breakdown evidence for a diamond-based structure after 300 MV/m, 35 ns long pulse. The electrical and mechanical properties of diamond make it an ideal candidate material for use in dielectric rf structures: high breakdown voltage, extremely low dielectric losses and the highest thermo-conductive coefficient available for removing waste heat from the device. We also report on a collinear wakefield experiment using the first tunable dielectric loaded accelerating (DLA) structure. By introducing an extra layer of nonlinear ferroelectric, which has a dielectric constant sensitive to temperature and DC bias, the frequency of a DLA structure can be tuned. We report on our recent experiments in this field.

Name of submitting author	Selina Li
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Abstract Title	**Head Erosion with Emittance Growth in PWFA**
Author/Affiliation listing	**S. Z. Li**, E. Adli, S. Corde, R. J. England, J. Frederico, M. J. Hogan, M. D. Litos, D. R. Walz (SLAC, Menlo Park, CA 94025, U.S.A.) W. An, C.E. Clayton, C. Joshi, W. Lu, K.A. Marsh, W. Mori, S. Tochitsky (UCLA, Los Angeles, CA 90095, U.S.A.) P. Muggli (Max Planck Institute for Physics, Munchen, Germany)
Abstract	We present a study of head erosion with emittance growth in field-ionized plasma from the PWFA experiments performed at FACET user facility at SLAC.
Summary	
Head erosion is one of the limiting factors in plasma wakefield acceleration (PWFA). We present a study of head erosion with emittance growth in field-ionized plasma from the PWFA experiments performed at FACET user facility at SLAC. At FACET, a 20 GeV electron beam with 1.8x10^10 electrons is optimized in beam spot size and combined with a high-density lithium plasma to provide beam-driven PWFA. A target foil is inserted upstream of the plasma source to increase the emittance through multiple scattering. Its effect on beam-plasma interaction is observed in an energy spectrometer after a vertical bend magnet. Scaling of the head erosion rate with emittance is compared with theoretical predictions.	

Name of submitting author	Dr. Alberto Martinez de la Ossa
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Abstract Title	**Self-modulation of long electron beams in plasma at PITZ.**
Author/Affiliation listing	**Alberto Martinez de la Ossa[1]**, Matthias Gross[1], Martin Khojoyan[1], Mikhail Krasilnikov[1], Anne Oppelt[1], Frank Stephan[1], Florian Grüner[2], Carl Schroeder[3], and Jens Osterhoff[2]. 1 Deutsches Electronen-Synchrotron DESY, Germany. 2 University of Hamburg, Germany . 3 Lawrence Berkeley National Laboratory, USA.
Abstract	The Photo Injector Test facility at DESY (PITZ) offers the unique possibility to study and demonstrate the self-modulation of long electron beams when propagating into a uniform plasma. The experiment aims to recover key physics for the design of future beam-driven plasma wakefield acceleration experiments.
Summary	
Beam-driven plasma wakefield acceleration has generated a high scientific interest since it was experimentally proven that electrons can be accelerated up to energies close to 100 GeV in less than a meter of propagation in plasma [Nature 445 (2007) 741-744]. Recently, it has been proposed to use the high energetic (450 GeV) proton beams from the CERN SPS to drive a plasma wave [Conf.Proc. C100523 (2010) THPD050] which would potentially be able to accelerate electron beams into the TeV energy regime in a single stage. The whole project relies on the fact that a long proton bunch (L≫λp) is self-modulated through its propagation in plasma, splitting itself in ultrashort sub-bunches of length ~λp, which then can resonantly excite the plasma wave. The Photo Injector Test facility at DESY, Zeuthen site (PITZ), offers the unique possibility to study and demonstrate this self-modulation effect by using long electron bunches in plasma. A set of numerical simulations with the particle-in-cell code Osiris[Lect. Notes Comput. Sci. 2331, 342 (2002)] has been carried out for a better understanding of the process. Of particular interest is the measurement of the energy modulation induced to the beam itself by means of the generated wakefields in plasma. It will reflect the key properties of the accelerating electric fields like their magnitude and their phase velocity, both of significant importance in the design of experiments relying on this technique.	

Name of submitting author	Behnam Montazeri
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Abstract Title	**Particle-In-Cell and Time Domain Simulation of Beam Dynamics and Wakefields in Laser-Driven Double Grating Accelerator**
Author/Affiliation listing	**Behnam Montazeri N.** / SLAC National Lab, Stanford University Rebert L. Byer / Stanford University Cho Ng / SLAC National Lab
Abstract	The idea of developing high gradient laser driven dielectric structures for electron acceleration has been a topic of interest over recent years. In this paper we present the results of beam dynamic and short range longitudinal wake field simulation of double grating accelerating structure.

Summary

Due in part to the small (micron-scale) beam apertures of advanced accelerator schemes using dielectric micro-structures driven by lasers, beam dynamics and wake effects in these structures are of particular interest. We have developed a MATLAB code for beam dynamic studies. The code uses electromagnetic fields from HFSS simulation of a dual-grating accelerator topology similar to that proposed by Plettner, Lu, and Byer in [PR-STAB 9, 111301 (2006)]. We set periodic boundary condition for the one period of grating structure and find electromagnetic fields inside the channel. Having the fields imported in MATLAB, we step an electron with arbitrary phase inside the time varying accelerating fields to find the expected gradient and deflection of that electron. The highest expected gradient has been calculated to be 0.47E0 where E0 is the maximum Electric field of the incident laser. Furthermore we calculate the transmission matrices for this structure and present the beam dynamic simulations for an electron bunch passing through the structure. We present results of expected system performance by the code, and discuss the necessary optimization to design and fabrication, which will be followed by simulation of a many-period structure. We also discuss particle-in-cell simulations with ACE3P simulation package at SLAC. T3P tool from ACE3P package enables us to do time domain electromagnetic simulation of the beam inside the grating structure, followed by calculation of longitudinal wakes in the structure. We study the convergence of numerical methods for calculating wake fields and finally having metallic beam pipes added at both ends of the structure, we can see that the short range longitudinal wake fields are in the order of 10^4 to 10^5 V/pC which keeps us in the safe side to operate this structure under beam loaded conditions.

References:

1) T. Plettner, P. Lu, R.L. Byer, “Proposed few-optical cycle laser-driven particle accelerator structure,” Phys. Rev. ST Accel. Beams 9, 111301 (2006).
2) Johnny S.T. Ng, “Wakefield Simulations for the Laser Acceleration Experiment at SLAC”, AAC2010

Name of submitting author	Prof. Patric Muggli
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Abstract Title	**Plasma Wakefields Resonant Excitation**
Author/Affiliation listing	**P. Muggli** Max Planck Institute for Physics, Munich, Germany & University of Southern California, Los Angeles, CA 90089, USA B. Allen, Y. Fang University of Southern California, Los Angeles, CA 90089, USA V. E. Yakimenko, M. Babzien, M. Fedurin, K. P. Kusche, C. Swinson, R. Malone Brookhaven National Laboratory, Upton, Long Island, NY 11973, USA
Abstract	We demonstrate that plasma wakefields can be resonantly driven to large amplitude by a train of electron bunches. We also show that shaped bunches leading to large transformer ration can be generated using a mask technique.

Summary

Plasma wakefields ca be driven to large amplitude by a train of equidistant charged particle bunches. We vary the plasma accelerator frequency by more than two orders of magnitude by changing the plasma frequency. We demonstrate that when the plasma period is equal to the drive bunch train period resonant excitation occurs. However, this leads to low transformer ratio. In order to reach a large transformer ratio (R>2), the charge of the bunch or train must be varied. We use a masking technique we previously developed [P. Muggli et al., Phys. Rev. Lett. 101, 054801 (2008)] to produce ramped bunch trains as well as triangular bunches. A large transformer ratio cannot be maintained upon propagation in the linear regime. We show through numerical simulations that in the quasi-linear regime of the PWFA, taking advantage of the linear superposition of the wakefields and of the weakly dependence of the accelerating fields on the bunch transverse s ize, a transformer ratio R>2 can be maintained while propagating along the plasma. In this case, the three drive bunches loose energy at approximately the same rate, in principle allowing for large energy transfer efficiency to the witness bunch.

This work is supported by the US department of Energy.

Name of submitting author	Dr. Philippe Piot RG
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Abstract Title	**A dielectric-wakefield energy-doubler module for the Advanced Superconducting Test Accelerator at Fermilab**
Author/Affiliation listing	**P. Piot**, D. Mihalcea, C. Prokop, Northern Illinois University and Fermi National Accelerator Laboratory P. Stoltz, Tech-X
Abstract	Fermilab is current constructing an accelerator test facility, the Advanced Superconducting Test Accelerator. The facility will initially produce 250-MeV and eventually up to 700-MeV electron beams. In this contribution we explore the upgrade of this facility with advanced phase space manipulations and dielectric-lined structure to produce higher-energy low-charge electron bunches.

Summary

The Advanced Superconducting Test Accelerator in construction at Fermilab will produce high-charge (~<3 nC) 250-750-MeV electron bunches. The facility is based on a superconducting linac capable of producing up to 3000 bunches in 1-ms macropulses with macropulses repeated at 1 Hz. In this contribution we explore the use of a short dielectric-lined-waveguide (DLW) linac to significantly increase the bunch energy. The method consist in (1) using advanced phase space manipulation to shape the beam current [i] and enhance the transformer ratio, and (2) use a dedicated high-frequency photo-injector to produce low charge witness bunch. Start-to-end simulations are presented. The DLW linac is simulated with the finite-difference time-domain program VORPAL and a with a modified version of the IMPACT-T particle-in-cell code [ii]. This DLW module could also be used to test some of aspects the proposed concept toward a DLW-based short-wavelength free-electron laser [iii].

[i] P. Piot, Y.-E Sun, J. Power, M. Rihaoui, Phys. Rev. ST Accel. Beams 14, 022801 (2011).
[ii] D. Mihalcea, P. Piot, and P. Stoltz, "Three-Dimensional Analysis of Wakefields Generated by Flat Electron Beams in Planar Dielectric-Loaded Structures", arXiv:1204.6724v1 [physics.acc-ph] (2012).
[iii] C. Jing, J. G. Power and A. Zholents, "Dielectric Wakefield Accelerator to Drive the Future FEL Light Source", LS-ANL/APS/LS-326; technical note Argonne National Accelerator (2011).

Name of submitting author	Prof. James Rosenzweig
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Abstract Title	**Wakefield Tests in Optimized Photonic Structures**
Author/Affiliation listing	G. Andonian, E. Arab S. Barber, K. Fitzmorris, A. Fukusawa, B. Naranjo, B. O'Shea, **J. Rosenzweig**, H. Phuc, A. Valloni, O. Williams, UCLA M. Hogan, SLAC P. Muggli, MPI V. Yakimenko, BNL
Abstract	We describe experiments at the BNL ATF and SLAC FACET in which optimized photonic structures are utilized. These experiments, while are performed in the THz regime, have high relevance to the development of laser-driven accelerators such as the 5 micron wavelength GALAXIE structure.
Summary	
Pending	

Name of submitting author	Prof. James Rosenzweig
Institution	UCLA Dept. of Physics and Astronomy
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Abstract Title	**Experimental Testing of the PWFA Quasinonlinear Regime**
Author/Affiliation listing	UCLA Dept. of Physics and Astronomy
Abstract	The physical scenario known as the PWFA quasinonlinear regime is described, in which the major advantages of the blowout regime of the PWFA are preserved, while permitting resonant, multi-pulse excitation. The physics of this regime are delineated, and the initial proof-of-principle experiments at the BNL ATF are discussed.
Summary	
Pending	

Name of submitting author	Prof. Levi Schachter
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Abstract Title	**2D Formulation of E-beam Interaction with Multi-resonant Gaseous Medium**
Author/Affiliation listing	Miron Voin[1], Wayne Kimura[2], Patric Muggli [3,4] and **Levi Schächter[1]** (1)Dept. of Electrical Engineering, Technion, Haifa 32000, ISRAEL (2) STI Optronics, Bellevue, WA 98004, USA (3) Dept. of Electrical Engineering, University of Southern California, Los Angeles, CA 90089, USA (4) Max-Planck Institute für Physik, 80805 München, GERMANY
Abstract	Interaction of a beam of electrons with an excited gaseous medium is formulated and a few examples are presented.

Summary

Interaction of a beam of electrons with an excited gaseous medium is formulated and a few examples are presented. In the framework of the model, the dielectric properties of the gaseous medium are represented by a finite set of resonances corresponding to spectral lines of the gas constituents. Both stimulated emission and absorption from the various states are considered. It is assumed that the population of one of the energy states is inverted. Longitudinal and transverse dynamics are evaluated analytically and Panofsky-Wenzel theorem for such a medium is derived. Based on the numerical simulations performed, possible implications on the operation as either an afterburner or an injector are discussed.

Name of submitting author	Carl Schroeder
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Abstract Title	**Coupled hosing and self-modulation instabilities in proton beam driven PWFA**
Author/Affiliation listing	**C. B. Schroeder** (LBNL), C. Benedetti (LBNL), E. Esarey (LBNL), F. J. Grüner (Hamburg), W. P. Leemans (LBNL)
Abstract	A long beam propagating in an overdense plasma is subject to envelope modulation and centroid displacement (hosing) instabilities. Coupled equations for the beam centroid and envelope are solved. It is shown that the hosing growth is comparable to self-modulation, and coupling of self-modulation enhances hosing and induces harmonic content.

Summary

Recently the use of proton beams (such as those at CERN and Fermilab) to drive plasma waves for compact acceleration of electron beams has attracted considerable attention [see for example, Caldwell et al., Nature Physics (2009)]. Owing to the difficulty of proton beam compression, researchers are considering relying on the beam-plasma interaction to modulate the beam, driving a large plasma wave for acceleration. Experimental programs at CERN (using proton beams), and at BNL, SLAC, and DESY (using electron beams) are presently underway or being considered to test this concept and its applicability to the next generation of high-energy colliders. A self-modulated proton-driven PWFA presents many challenges. For example, it has been pointed out the the phase velocity of the self-modulated beam (in the linear regime) is significantly slower than the beam velocity [Schroeder et al. PRL (2011); Pukhov et al. PRL (2011)], resulting in beam dephasing. The dephasing could be compensated by tapering, although it was also shown that small plasma density inhomogeneities can strongly suppress the modulation [Schroeder et al., Phys. Plasmas (2012)]. In addition, the transverse stability of drive beams is a critical concern for beam-driven plasma wakefield accelerators, and in particular for long beams. This presentation will describe the physics of the beam hosing of a long (many plasma periods) charged particle beam undergoing the self-modulation instability while propagating in an overdense plasma [Schroeder et al., submitted (2012)]. In particular, the coupled evolutions for the beam centroid (hosing) and envelope (self-modulation) are analyzed and solved. The hosing growth rate is calculated. The coupling of the beam envelope self-modulation to the beam centroid displacement is shown to enhance beam hosing. Seeding options to increase beam self-modulation will be discussed.
Work supported by Office of High Energy Physics, of the US DOE, Contract No. DE-AC02-05CH11231.

Name of submitting author	Dr. Evgenya Simakov
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Abstract Title	**Possibility for Ultra-Bright Electron Beam Acceleration in Dielectric Wakefield Accelerators**
Author/Affiliation listing	**Evgenya I. Simakov** and Bruce E. Carlsten Los Alamos National Laboratory
Abstract	We present a conceptual proposal to combine the Dielectric Wakefield Accelerator (DWA) with the Emittance Exchanger (EEX) to demonstrate a high-brightness DWA with the gradient of above 100 MV/m and less than 0.1% induced energy spread in the accelerated beam.

Summary

We currently evaluate the DWA concept as a performance upgrade for the future LANL signature facility MaRIE with the goal of significantly reducing the electron beam energy spread. The Matter-Radiation Interactions in Extremes (MaRIE) experimental facility will be used to discover and design the advanced materials needed to meet 21st century national security and energy security challenges. The pre-conceptual design for MaRIE is underway at LANL, with the design of the electron linear accelerator being one of the main research goals. The cost of the linac is significant and the LANL space constraints dictate that the final energy of the electron beam for the X-ray Free-Electron Laser (XFEL) is no higher than 12 GeV. The number and the energy of photons produced by the XFEL is however strongly dependent on the electron beam's energy with the more energetic beam delivering more energetic photons to the user. Although generally the baseline design needs to be conservative and rely on existing technology, any future upgrade would immediately call for looking into the advanced accelerator concepts capable of boosting the electron beam energy up by a few GeV in a very short distance without degrading the beam's quality. Scoping studies have identified large induced energy spreads as the major cause of beam quality degradation in high-gradient advanced accelerators for FELs. Among advanced accelerator technologies, DWAs hold significant advantages over plasma wakefield accelerators due to the elimination of plasma-induced effects (e.g. bunch erosion and hosing), the fact that having the wakefield in vacuum ensures linearity, and their higher technological maturity. We will present simulations demonstrating that trapezoidal bunch shapes can be used in a DWA to greatly reduce the beam energy spread, and, in doing so, also preserve the beam brightness at levels never previously achieved. This concept has the potential to advance DWA technology to a level that would make it suitable for the proposed Los Alamos MaRIE signature facility.

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Abstract Title	**Self-modulation of long lepton and hadron bunches**
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Abstract	We explore the self-modulated plasma wakefield accelerator driven by proton and lepton bunches. We find that the key physics can be explored using long lepton bunches at SLAC FACET which can lead to the generation of accelerating gradients larger than 20 GV/m and to 10 GeV lepton bunch energy variation.
Summary	
Proton bunches are attractive for plasma wakefield acceleration because the total amount of energy they carry is much larger than that of the lepton bunches of a future linear collider. The initial proposal for a proton-driven PWFA (or PDPWFA) [1] considered the case of a short proton bunch driver (shorter than 100 microns). However, such short proton bunches are not currently available. It was recently suggested [2] that the self-modulation (S-M) of a long proton bunch at the wavelength of the relativistic plasma wave can lead to the resonant excitation of large amplitude plasma wakefields. In this work we explore the self-modulation of ultra-relativistic hadron and lepton bunches. We show that the self-modulation of 0.5 TeV, 12 cm long proton bunches can lead to large accelerating gradients (>200 MeV/m) in 5 meter long plasmas with 10^14 electrons/cm^3. The plasma ion motion can degrade the wakefields and suppress the self-modulation instability unless heavier plasma ions are used (e.g. Argon) [3]. Furthermore, the physics of the PDPWFA could be tested very soon with the ultra-relativistic (E=25 GeV) and long (500 microns) lepton bunches available at SLAC FACET [4]. 3D simulations reveal that hosing may limit S-M, but that hard-cut bunches ensure that saturation of S-M can be reached. The saturation of the S-M instability is reached over only a few centimeters of plasma at a density of 2.3x10^17/cm^3. Accelerating gradients in excess of 20 GeV/m can be generated, and energy variations up to 10 GeV at the 1% level were observed after one meter. We find that the self-modulation of positively and negatively charged bunches differ. Because the blowout	

regime is reached, positron driven wakes lead to accelerating gradients that can be less than half than those of electrons [5].

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Abstract Title	**Frequency-domain inteferometric visualization of electron-bunch-driven wakes**
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Abstract	We report progress in the development of single shot Frequency-Domain Holographic (FDH) probing of two, and multibunch, driven plasma wakefield structures, in the Accelerator Test Facility at the Brookhaven National Laboratory.

Summary

Beam-driven plasma wakefield accelerators (PWFA), such as the ``plasma afterburner,'' can potentially greatly increase the particle energies of conventional accelerators [1]. Various schemes using single and multiple bunches of electrons, positrons and protons have been investigated. Appropriately delayed witness bunches have been the usual method to probe the fields of such wakes, and indirectly, the corresponding plasma wake structures. However, the wake structure has not been observed directly in the PWFA. We will report our progress in the development of direct, optical interferometric methods of measuring the plasma density modulation in electron beam driven wakefields [2,3]. Frequency Domain Holography (FDH) [3], employing two chirped laser pulses (probe and reference) co-propagating with the particle drive-beam and its plasma wake, permits a single shot observation of an extended section of the wakefield behind a drive bunch. The chirped, temporally stretched, probe samples several periods of the wake, while the undisturbed reference pulse propagates ahead of the electron drive bunch. The technique is being developed in the Accelerator Test Facility at the Brookhaven National Laboratory as a probe for two and multibunch driven plasmawakefield experiments [4,5].

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