Working Group 3:

Laser and High-Gradient Structure-Based Acceleration

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Abstract Index

Name of submitting author	Scott Anderson
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Abstract Title	**Inverse Free-Electron Laser Acceleration using Ti:Sapphire Lasers**
Author/Affiliation listing	**S. G. Anderson** - LLNL, D. J. Gibson - LLNL, A. M. Tremaine - LLNL, S. S. Wu - LLNL, J. T. Moody - UCLA, P. Musumeci - UCLA
Abstract	We investigate the application of ultra-fast Ti:Sapphire laser technology to Inverse Free-Electron Laser acceleration in the regime where the number of undulator periods and drive laser oscillations is comparable. Simulations and theoretical models are used to predict IFEL performance in this regime and the LLNL/UCLA experiment is presented.
Summary	
Previous IFEL acceleration experiments have demonstrated both high gradient and capture fraction using CO2 laser technology. In these experiments the laser pulse duration was much longer than that of the electron bunch and the temporal dependence of laser intensity was largely ignorable. Titanium Sapphire laser technology coupled with permanent magnet undulators is ideally suited to producing meter-scale, GeV IFEL accelerators. We examine the technical challenges of using a Ti:Sapphire laser in an IFEL accelerator. In particular, the effects of the laser duration being short compared to both the electron bunch and the IFEL interaction duration are investigated using theory and simulations. The current status of the LLNL/UCLA IFEL experiment is presented in which a 100 femtosecond Ti:Sapphire laser pulse is used to accelerate electron beams by 150 MeV in a 50 cm undulator. Future upgrades to the laser and undulator can enable a compact Ge V accelerator for driving Compton-scattering and XFEL light sources.	

Name of submitting author	Dr. Sergey Antipov
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Abstract Title	**Experimental demonstration of wakefield effects in a THz planar diamond accelerating structure**
Author/Affiliation listing	C. Jing, **S. Antipov**, P. Schoessow, J. Butler, S. Zuo and A. Kanareykin / Euclid Techlabs, LLC, 5900 Harper Rd, Solon, OH-44139. W. Gai / High Energy Physics Division, Argonne National Laboratory, Argonne, IL-60439. V. Yakimenko, M. Fedurin, K. Kusche / Accelerator Test Facility, Brookhaven National Laboratory, Upton, NY-11973
Abstract	In this paper we present results from wakefield tests of structures at the Accelerator Test Facility (ATF at BNL). We have directly measured THz wakefields induced by a subpicosecond, intense relativistic electron bunch in a diamond loaded accelerating structure via the wakefield acceleration method.

Summary

Diamond has been studied as a candidate for dielectric loaded accelerating structures. It has low microwave loss, high breakdown threshold and the highest available thermoconductive coefficient. High quality diamond can be grown using a chemical vapor deposition process. Surface treatment, like dehydrogenation or oxidation, can dramatically reduce secondary electron emission from the diamond.
measured THz wakefields induced by a subpicosecond, intense relativistic electron bunch in a diamond loaded accelerating structure via the wakefield acceleration method. We present here the beam test results from the diamond-based structure. Diamond has been chosen for its high breakdown threshold and unique thermoconductive properties. Fields produced by a leading (drive) beam were used to accelerate a trailing (witness) electron bunch, which followed the drive bunch at a variable distance. The energy gain of a witness bunch as a function of its separation from the drive bunch describes the time structure of the generated wakefield.

Ref: [1] S. Antipov, et. al. Appl. Phys. Lett. 100, 132910 (2012)
[2] S. Antipov, et al, Proc. PAC11, 2011, pp. 2074-2076.
[3] S. Antipov, et al., Proc AAC10., pp. 359-363 (2010).

Name of submitting author	Dr. Sergey Antipov
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Abstract Title	**Terahertz Coherent Cherenkov Radiation (CCR) via Self-Wake-Based Beam Bunching**
Author/Affiliation listing	C. Jing, **S. Antipov**, P. Schoessow, and A. Kanareykin / Euclid Techlabs, LLC, 5900 Harper Rd, Solon, OH-44139. W. Gai / High Energy Physics Division, Argonne National Laboratory, Argonne, IL-60439. V. Yakimenko / Accelerator Test Facility, Brookhaven National Laboratory, Upton, NY-11973 A. Zholents / Advanced Photon Source, Argonne National Laboratory, Lemont, IL-60439
Abstract	We present a design for a table top, narrow bandwidth THz beam based source. A self-wake is used to modulate the energy of originally chirped long beam. Then a chicane is used to convert this modulation into a THz bunch train.

Summary

A table top device producing high power beams is described. A rectangular beam with linear energy chirp that can be produced out of the photo injector via pulse shaping of the laser running off-crest is sent through the dielectric loaded waveguide. Because of its self-wake, the beam's energy becomes modulated. In the chicane following the energy-bunching section this modulation is converted to a density modulation—a bunch train. Several examples are discussed demonstrating bunching in the THz region. The density modulated beam can pass through a power extraction section, like dielectric loaded accelerating structure or simply hit a target, producing THz radiation.
will also present results from the experiment at the ATF (BNL) [1] in which we observed beam energy bunching due to the self-wake in dielectric loaded wakefield structures. Experimental results are compared with simulation and good agreement is observed.

Ref:
[1] S. Antipov, et al., Phys. Rev (2012)
[2] D. Xiang et. al. Phys. Rev. Lett. 108, 024802 (2012)
[3] G. Andonian et. al. Appl. Phys. Lett. 98, 202901 (2011)

Name of submitting author	Carl Bauer
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Abstract Title	**Wakefields in photonic crystal cavities**
Author/Affiliation listing	Gregory R. Werner, University of Colorado at Boulder John R. Cary, University of Colorado at Boulder and Tech-X Corporation
Abstract	Wakefields due to low-group-velocity modes can be troublesome in photonic-crystal-based accelerating structures. We compare wakefields in hybrid dielectric-metal photonic crystal cavities and the waveguide-damped CLIC cavity.

Summary

Future particle accelerator cavities may use dielectric photonic crystals to reduce harmful wakefields and increase the accelerating electric field (or gradient). Reduced wakefields are predicted based on the bandgap property of some photonic crystals (i.e. frequency-selective reflection/transmission). Larger accelerating gradients are predicted based on certain dielectrics' strong resistance to electrical breakdown. Using computation, this work investigated a hybrid design of a 2D sapphire photonic crystal and traditional conducting cavity. The goals were to test the claim of reduced wakefields and, in general, judge the effectiveness of such structures as practical accelerating cavities. In the process, we discovered the following: (1) truncated photonic crystal cavities may confine radiation weakly compared to conducting cavities (depending on the level of truncation); however, confinement can be dramatically increased through optimizations that break lattice symmetry (but retain certain rotational symmetries); (2) photonic-crystal-based cavities do not ideally reduce wakefields; using band structure calculations, we found that flat portions of the frequency dispersion (i.e. low-group-velocity modes) increase wakefields. A complete comparison was drawn between the proposed photonic crystal cavities and the copper cavities for the Compact Linear Collider (CLIC); CLIC is one of the candidates for a future high-energy electron-positron collider that will study in greater detail the physics learned at the Large Hadron Collider. We found that the photonic crystal cavity, when compared to the CLIC cavity: (1) can lower maximum surface magnetic fields on conductors (growing evidence suggests this limits accelerating gradients by inducing electrical breakdown); (2) shows increased transverse dipole wakefields but decreased longitudinal monopole wakefields; and (3) exhibits lower accelerating efficiencies (unless a large photonic crystal is used).

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	Benjamin Cowan
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Abstract Title	**Origin and mitigation of trapped modes between multicell RF accelerator cavities**
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Abstract	We demonstrate that the photonic bandgap effect can trap an electromagnetic mode between two multicell RF cavities. From this information we devise a simple modification to the structure geometry that eliminates such trapped modes.

Summary

Long range wakefields are generated when a particle bunch excites a resonant mode in an RF structure. Such modes can then affect subsequent bunches degrading beam quality. This is especially serious in high-energy colliders, where luminosity is achieved in part by the use of long bunch trains. It is therefore critical to understand and mitigate, to the extent possible, deleterious long range wakefields.

trapped resonant mode could exist in a beam pipe between a pair of multicell RF cavities [1]. Here we pinpoint the origin of that mode as confinement due to the one-dimensional photonic bandgap effect of the quasi-periodic, 9-cell ILC accelerator structure. We first show computations of the longitudinal bandstructure of the ILC cavity, using the Vorpal time-domain code [2] together with the filter diagonalization method for frequency extraction [3]. We then compute the trapped mode, showing that its frequency lies within the 1D bandgap of the cavity and that additional modes arise as the pipe is lengthened so that additional resonances enter the bandgap. We demonstrate that the trapped mode can be eliminated by narrowing the beam pipe, increasing its cutoff frequency into the passband of the cavity.

which were conducted using the Vorpal implementation of electromagnetics on graphics processing units.

Work supported by U. S. Department of Energy, Office of Science/High Energy Physics grant DE-FC02-07ER41499 (SciDAC).

[1] C. Ng et al., "State of the art in EM field computation," SLAC-PUB-12020 (2006).
[2] C. Nieter and J. R. Cary, J. Comput. Phys. 196, 538 (2004)
[3] G. R. Werner and J. R. Cary, J. Comput. Phys. 227, 5200 (2008).

Name of submitting author	Joseph Duris
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Abstract Title	**High Energy Gain Inverse Free Electron Laser Experiment**
Author/Affiliation listing	**Duris, Joseph**; Musumeci, Pietro; Li, Renkai
Abstract	Initial beam and laser transport for a high gradient high energy inverse free electron laser experiment

Summary

Inverse Free Electron Laser (IFEL) interaction is suitable for mid to high energy range compact accelerators. The primary goal of the Rubicon IFEL experiment is to achieve energy gain and gradient significantly larger than what is possible with conventional RF accelerators by using a strongly tapered helical undulator with Brookhaven-National-Laboratory's Accelerator-Test-Facility (ATF) e-beam and high-power CO2 laser system. Simulations predict acceleration of a 50MeV beam to 117MeV with 500GW of laser power.

varying from 40cm to 60cm and offset in phase by pi/2. The on-axis magnetic fields were simulated with Radia and were found to agree well when measured with a BH205 transverse hall probe. We used the second integral of the magnetic field to tune the particle trajectories to keep them from deviating off-axis and minimize the beam's slope.

length determined by the geometry and available laser power of ATF's CO2 laser system. Preliminary measurements of the CO2 pulse near the midpoint of the undulator suggest acceptable focal size, Rayleigh range, and waist position.

available for acceleration was estimated by measuring the laser pulse energy with a joule meter and average pulse duration with spectras. The pulse length and fraction of energy in each pulse was measured with a streak camera, and the fraction lost to tails was measured by imaging the transverse profile near the focus.

lattice was simulated with Elegant and tuned to achieve a beta function of 37cm at the undulator's entrance in order to match into the undulator and minimize the spot size on a spectrometer designed to accept energies from 50MeV to 120MeV. A germanium wafer was used to synchronize the e-beam and laser.

energy-spread of 6.7MeV. This is smaller than simulations with the estimated available power of 240GW and linear-polarization suggesting unaccounted power-losses or alignment issues. Switching to circular-polarization, better alignment, and optimizing laser output will improve these results in the coming months.

Name of submitting author	Dr. R. Joel England
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Abstract Title	**Cherenkov Wakefield Excitation in Photonic Crystal Fiber Accelerators**
Author/Affiliation listing	E. R. Colby, R. Laouar, C. M. McGuinness, B. Montazeri, C.-K. Ng, R. J. Noble, E. Peralta, K. Soong, J. E. Spencer, D. Walz, Z. Wu, D. Xu / SLAC
Abstract	We report on the successful excitation and measurement of the spectral content of the wakefield radiation in several photonic bandgap (PBG) hollow-core optical fibers, at least one of which is predicted in simulations to support TM-like accelerating modes. We compare these results with simulations obtained using frequency and time-domain codes.

Summary

A variety of dielectric photonic crystal structures have been proposed in recent years as high-gradient accelerators that can be driven by moderately powered infrared lasers. Techniques for experimentally detecting and characterizing the available speed-of-light modes in such structures are therefore of interest. One technique is to excite the structure with a speed-of-light electron bunch and spectrally analyze the produced wakefield radiation, which will consist of a superposition of the electromagnetic modes of the structure. We report on the successful excitation and measurement of the spectral content of the wakefield radiation in several commercially available photonic bandgap (PBG) hollow-core optical fibers, at least one of which is predicted in simulations to support TM-like accelerating modes. We compare these results with simulations obtained using a combination of frequency and time-domain codes.

*Work supported in part by the U.S. Department of Energy under contract number DE-AC02-76SF00515

Name of submitting author	Dr. Luigi Faillace
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Abstract Title	**High-power Tests of an Ultra-High Gradient Compact S-Band Accelerating Structure**
Author/Affiliation listing	**Luigi Faillace** - RadiaBeam Technologies Ronald Agustsson, Pedro Frigola, Alex Murokh (RadiaBeam, Santa Monica) Vitaly Yakimenko (BNL, Upton, Long Island, New York) Valery Dolgashev (SLAC, Menlo Park, California) James Rosenzweig (UCLA, Los Angeles, California)
Abstract	RadiaBeam Technologies presents the RF design, fabrication and high-power tests of a ultra-high gradient (50MV/m) S-Band accelerating structure (HGS) operating in the pi-mode at 2.856 GHz.
Summary	
A high-gradient accelerating S-band structure (HGS) is under development at RadiaBeam Technology to potentially increase the accelerating gradients available at S-band up to 50 MV/m, significantly above the current state-of-the-art. The HGS structure takes advantage of methodology and innovative design solutions developed for the X-band structures by NLCTA collaboration at SLAC, including optimized couplers design, precision surface processing and cleaning techniques, reduced pulsed heating RF cycle dynamics and improved RF thermal load management. In this paper, the HGS structure RF design, fabrication process, as well as the initial results of high-power tests at LLNL are presented, and future development outlook is discussed. * Work supported by US DOE grant # DE-SC000866.	

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Abstract Title	**High Power X-band Pulse Compressor Using Electron Beam Switching**
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Abstract	The paper will present results from an active X-band pulse compressor using electron-beam driven switching. The compressor has produced ~22 ns FWHM pulses at >15x gains. It is currently undergoing testing in the NRL Magnicon Facility at drive powers of up to 10 MW. The latest results will be presented.
Summary	
A proposed future TeV collider operating at X-band will require high peak rf powers of hundreds of MW in pulses lasting hundreds of nanoseconds. One method to provide such pulses is through the use of rf pulse compressors to multiply the power produced by high-power klystrons producing multi-microsecond pulse widths. Such compressors can be passive, employing phase switching to discharge rf energy storage cavities, such as SLED 2, or active, in which a triggered increase in the output coupling coefficient of the energy storage cavities is used to extract the high power rf pulse. Active microwave pulse compressors are of interest because they are capable of both higher compression ratios and higher efficiencies than passive compressors. In a series of experiments, a team of researchers from the Institute of Applied Physics of the Russian Academy of Science, Omega-P, Inc., and the Naval Research Laboratory previously investigated active puls e compressors using a plasma discharge to Q switch the energy storage cavities that achieved compressed pulses of 50–70 MW peak power and 40–70 ns durations. Peak power gains were in the range of 7:1–11:1 with efficiencies in the range of 50%–63%. [1]. This paper describes a novel active microwave pulse compressor that makes use of electron beam switching [2] to improve on the previous approach. We will describe the design and low power tests of this concept, and present the results of tests at the Naval Research Laboratory Magnicon Facility at drive powers of up to 10 MW. S.V. Kuzikov, M.A. Lobaev, J.L. Hirshfield, S.H. Gold and A.K. Kinkead, “High Power Active X-Band Pulse Compressor Using Plasma Switches,” Phys. Rev. ST Accel. Beams, vol. 12, 062003 (2009). “High power microwave switch employing electron beam triggering with application to active rf pulse compressors,” Phys. Rev. ST Accel. Beams, vol. 14, 061301 (2011).	

Name of submitting author	Dr. Daniel Gordon
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Abstract Title	**Nonlinear Optics in a PIC Framework**
Author/Affiliation listing	Michael Helle, Joe Penano, Bahman Hafizi*, Antonio Ting, Dmitri Kaganovich Naval Research Laboratory, Washington, DC *Icarus Research, Inc., Bethesda, MD
Abstract	A numerical model that incorporates nonlinear optical materials into a particle-in-cell (PIC) framework is described. In terms of advanced accelerators, the model is useful for modeling the interaction of ultra-short electron bunches with electro-optic crystals, or dielectric structures. The algorithm is detailed, and results pertaining to advanced accelerators are presented.
Summary	
The interaction of an ultra-short electron bunch with nonlinear optical materials is of interest in connection with a variety of acceleration and radiation generation processes, such as electro-optic sensing, acceleration in dielectric structures, transition radiation processes, or Smith-Purcell processes. To model the fields due to an ultra-short, relativistic, electron bunch, the particle-in-cell technique is often used. Many of the techniques that are used to model free charges can be adapted to model bound charges in anharmonic, anisotropic, potential wells. By loading a multi-species population of such bound charges onto the numerical grid, one may simulate the dielectric response of a real material over a broad range of frequencies. The numerical dispersion relation and stability criterion are discussed in relation to those of an ordinary PIC code. Source deposition techniques for bound charges are compared with those for free charg es. Results from the code are presented, illustrating ordinary nonlinear optics, the nonlinear optics of nano-composites, and the interaction of an ultra-short electron bunch with electro-optic crystals [M.H. Helle et al., Phys. Rev. ST/AB, accepted]. This work is supported by the Naval Research Laboratory Base Program, the Department of Energy, and by NERSC	

Name of submitting author	Jay L Hirshfield
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Abstract Title	**Modified Magnicon for High-Gradient Accelerator R&D**
Author/Affiliation listing	**J.L. Hirshfield**,[1,2] S.V Shchelkunov,[1] M.A. LaPointe,[1] Y. Jiang[1], V.P. Yakovlev,[2,3] [1]Department of Physics, Yale University, New Haven, CT, USA, [2]Omega-P, Inc., New Haven, CT, USA, [3]Fermi National Accelerator Laboratory, Batavia, IL, USA
Abstract	A design is presented of a modified 34.3 GHz magnicon amplifier with a TE_{311}-mode output cavity, to replace the existing magnicon at Yale Beam Physics Lab Test Facility whose output cavity operates in the TM_{310} mode. The main goal for the new design is to achieve robust day-to-day reliable operation.

Summary

The 34.3 GHz magnicon [1], developed by Omega-P beginning in 1996, was a key element at the Yale University Beam Physics Laboratory [2]. As configured, the tube could, however, supply limited—but diminishing—RF power for a number of current advanced accelerator R&D and particle physics experiments. Explanations were found to originate with the design itself, with the processing regimen to which the tube was subjected, and probably to unavoidable internal damage during its eight years of operation. A new design has been developed. In order to have a robust tube working 24/7, with output power ~25 MW in Ka-band at a 10 Hz repetition rate in pulses up to 1.3 microsec long, the following steps are to be followed: (a) as for other tubes designed for high-power, the modified magnicon is to be a fully brazed assembly without ceramics (save for the gun insulator); (b) the design is to allow bake-out up to 600°C to successfully condition it in a reasonable time; and (c) the tube's output cavity is to operate in the TE_{311} mode, allowing a noticeable decrease in the RF field magnitude on the cavity walls, as compared to the presently employed TM_{310} mode; in addition this allows a significant decrease in the guide magnetic field, and leads to a wider bandwidth—thus making the tube performance far less sensitive to operating parameters, which is critical during conditioning and routine operation. Development of a TE-mode output cavity is the main scientific innovation in this design. The new tube, as with its predecessor, is a third harmonic amplifier, with drive and deflection gain cavities near 11.424 GHz and output cavity at 34.272 GHz.

Supported by US Department of Energy.

O.A. Nezhevenko, et. al. IEEE Trans. on Plasma Science, vol. **32**, No 3, June 2004, pp. 994 – 1001
M.A. LaPointe, et. al. Proc. 13th Adv. Accel. Concepts Workshop, Santa Cruz, CA 27

July-2 August, 2008, AIP Conf. Proc. **1086** (2009) pp 470-476.	
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Abstract Title	**New RF Sources for Accelerators and Colliders**
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Abstract	Several new RF sources are in development for driving accelerators and colliders. These sources will be described and the status of the developments presented. This includes a multiple beam inductive output tube, an annular beam klystron, and periodic permanent magnet klystrons.
Summary	
New RF Sources for Accelerators and Colliders developed for accelerator and collider applications. Assembly is nearing completion on a multiple beam inductive output tube (IOT) at 352 MHz. This device is a potential replacement for the MW klystrons currently used at the Advanced Photon Source and is a potential source for ion and muon colliders. It is designed to operate at 200 kW CW with estimated efficiency of 70%. It is significantly smaller than klystrons at this frequency. An annular beam klystron was designed to produce 10 MW pulses at 1.3 GHz. The simulated performance matches the specifications of existing 10 MW multiple beam klystrons; however, the estimated cost is significantly less. The device uses a single electron gun and fundamental mode cavities with cutoff beam tunnels. The klystron will operate at 120 kV and generate 1.5 ms pulses. periodic permanent magnet (PPM) klystron at 2.15 GHz. These tubes will drive the Short Pulse X-Ray deflecting cavity RF system for the Advanced Photon Source upgrade. The magnet structure incorporates an innovative design that allows access to all cavities for cooling and tuning. This approach is also being applied to a 1.3 GHz, 500 kW RF source for Project X. PPM focusing eliminates requirements for a solenoid and the associated power supply and cooling system. This reduces both acquisition and operational costs. These new sources provide significant improvements over currently available source and offer higher performance and lower cost for future accelerating and collider systems. The designs for each will be presented as well as the status of the developments.	

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Abstract Title	**Multi-Harmonic RF Test Stand For RF Breakdown Studies**
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Abstract	A multi-harmonic RF test stand is under construction at Yale Beam Physics Lab. It employs a harmonic multiplier, which can generate multi-MW high power second-harmonic power efficiently that will be phase locked to the drive frequency. Its application for RF breakdown studies will be discussed.
Summary	
A multi-harmonic RF test stand is under construction at Yale Beam Physics Lab [1]. This harmonic multiplier is a novel gyroharmonic converter. It makes use of a fundamental-harmonic TE11-mode cyclotron autoresonance cavity accelerator (CARA) for initial beam formation followed by a higher mode TEm1 cyclotron resonance harmonic output cavity, where m is the harmonic number of the interaction. A new two-cavity version of second harmonic multiplier is designed to use a TE111 rotating mode input cavity with a TE211 5.712 GHz rotating mode output cavity. A seventh harmonic multiplier with 20 GHz output frequency using the same drive cavity has also been designed. Currently the drive cavity has been manufactured and tuned to the desired operation frequency. Application of the multi-harmonic RF test facility in RF breakdown studies will be discussed. A multi-harmonic asymmetric cavity is predicted to obtain lower RF breakdown probability than a conventional pillbox cavity, when driven by two or more external RF harmonic sources. Experimental efforts are underway to study RF breakdown in a bimodal asymmetric cavity powered by the multi-harmonic RF test stand. Research sponsored by US Department of Energy. [1] Multi-harmonic test setup for RF breakdown studies, Y. Jiang, S.V. Kuzikov, S.Yu. Kazakov, and J.L. Hirshfield, Nuclear Instruments and Methods A, Volume 657, Issue 1, Pages 71–77 (2011)	

Name of submitting author	Dr. Chunguang Jing
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Abstract Title	**Test of an X-band Standing Wave Dielectric Accelerating Structure**
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, R. Konecny, and W. Gai / High Energy Physics Division, Argonne National Laboratory, Argonne, IL-60439. S. Gold / Plasma Physics Division, Naval Research Laboratory, Washington DC, 20375. C.Chang, V. Dolgashev, and S. Tantawi , SLAC National Accelerator Laboratory, Menlo Park, CA 94025 USA
Abstract	An X-band standing wave dielectric accelerating structure has been developed and tested. We report on the experimental results as well as the new approach to completely suppress multipactor which appeared to be a critical issue during the experiment.
Summary	
A joint program is under way to study externally driven X-band dielectric-loaded accelerating (DLA) structures. The structures are designed and fabricated by Euclid Techlabs and Argonne National Laboratory and tested at up to 20 MW drive power using the X-band Magnicon Facility at the Naval Research Laboratory. In order to build up a high gradient with a limited rf power, a new high gradient standing-wave DLA structure has been developed and high power tested. Multipactor was found to prevent increasing the gradient inside the dielectric cavity beyond 10MV/m. A simple model has been constructed that shows good agreement with the experiment. A new approach to completely suppress the multipactor in DLA structures using an axial magnetic field has been proposed lately. More experiments are planned. The work is funded through DoE SBIR Program under Contract #DE-SC0006303, #DE-SC0007629. Ref: [1] C. Chang, et al, J. Appl. Phys. 110, 063304 (2011). [2] S. Gold, et al, Proc. PAC11, 2011, pp. 337-339.	

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Abstract Title	**Role of Nottingham and Thomson effects in heating of micro-protrusion in high-gradient accelerating structures.**
Author/Affiliation listing	**A. C. Keser** (1), G. S. Nusinovich (1), D. G. Kashyn (1), and T. M. Antonsen, Jr.(1) (1)Institute for Research in Electronics and Applied Physics University of Maryland MD 20742, USA
Abstract	RF field penetration inside protrusion of a metal with finite conductivity is considered. Field profile is obtained and heat equation is simulated on a Finite Element Analysis framework. Thomson Effect and Nottingham heating cooling is coupled to the model and their effects on the heating and field profiles are discussed.
Summary	
Role of Nottingham and Thomson effects in heating of micro-protrusion in high-gradient accelerating structures. Antonsen, Jr. of Maryland MD 20742, USA appearance of the RF breakdown which limits operation of high-gradient accelerating structures is the electron dark current [1]. This field-emitted current, usually considered as a precursor of the breakdown, can be emitted from apexes of microprotrusions on a structure surface. Therefore field and thermal processes in such protrusions deserve careful studies [2, 3]. The goal of our first study [3] was to analyze 2D process of RF field penetration inside protrusion of a metal with finite conductivity and to study corresponding Joule heating. In the present study, we include into consideration, first, the Nottingham effect, which may significantly change the protrusion heating. Then, since protrusion heating in high-power, short-pulse operation can be strongly non-uniform, we include into consideration also Thomson effect, which predicts additional heating/cooling in non-uniformly heated conductors. [1] Wang and Loew, SLAC PUB 7684 October 1997 [2]K.L.Jensen,Y.Y. Lau, D.W. Feldman, P.G. O'Shea, Phys. Rev. ST Accel.Beams 11, 081001(2008) [3] Kashyn et al, AAC-2010.	

Name of submitting author	Ki-yong Kim
Institution	University of Maryland
Email	kykim@umd.edu
Abstract Title	**Intense Broadband Terahertz Generation via Two-color Photoionization**
Author/Affiliation listing	**Ki-Yong Kim**/University of Maryland
Abstract	We review intense, broadband electromagnetic (EM) wave generation at terahertz (THz) and infrared (IR) frequencies in two-color, femtosecond laser ionization of gases. In particular, we report quasi-phase-matched THz generation in long plasma filaments and enhanced THz emission from 2-dimensional plasma sheets.

Summary

Intense terahertz (THz) radiation can be produced when an ultrashort pulsed laser's fundamental and second harmonic fields are mixed to ionize a gas [1-4]. Depending on the relative phase between two-color pulses, symmetry can be broken to produce a sub-picosecond electron current, producing THz radiation at the far-field (see Fig. 1). This plasma current model, first proposed by Kim et al. [2], is now widely adopted in the community.

producing intense THz radiation, and much of the current research in our lab is focused in that direction. Recently, we showed that such coherent radiation is extremely broad and may cover the entire infrared (IR) bandwidth (4 ~ 3000 um) [3]. In particular, in the case of near-atmospheric air, the radiation extends up to ~75 THz (corresponding to ~4 um) [3]. In addition, we recently observed quas -phase-matched THz generation in long plasma filaments. Our experiment and simulation show that the far-field terahertz radiation profiles and yields are greatly sensitive to the filament length. For plasma longer than the characteristic dephasing length, it emits conical terahertz radiation in the forward direction, peaked at 4~7 degrees depending on the radiation frequencies. The total terahertz yield continuously increases with the filament length, even beyond the dephasing length. This trend occurs regardless of the relative phase between two-color pulses in the filament. The quasi-phase-matching condition observed here provides a simple method for scalable terahertz generation in elongated plasmas.

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4. K. Y. Kim, "Quasi-Phase-Matched terahertz emission from two-color laser-induced plasma filaments," (submitted).

Name of submitting author	Dr. Rami Kishek
Institution	IREAP, University of Maryland
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Abstract Title	**Modeling of Multipactor in High-Gradient Structures**
Author/Affiliation listing	**R.A. Kishek**, O. Sinitsyn, and G. Nusinovich, IREAP, University of Maryland, College Park, MD 20742
Abstract	Multipactor limits the accelerating gradient of dielectric structures, and can be a factor in triggering breakdown in metallic structures. We present studies of multipactor using particle-in-cell code simulations. An analytical theory is developed revealing a new form of multipactor that considerably broadens the parameter range for the discharge.
Summary	
Multipactor, a resonant vacuum discharge based on secondary electron emission, limits the accelerating gradient of dielectric structures [1-2], and can be a factor in triggering breakdown in metallic structures. We present studies of multipactor using particle-in-cell code simulations. A novel resonant form [3] is proposed that combines one- and two-surface impacts within a single period, provided the total transit time is an odd number of rf half-periods, and the product of secondary yields exceeds unity. For low fD products, the simplest such mode is shown to significantly increase the upper electric field boundary of the multipacting region, and lead to overlap of higher-order bands. The results agree nicely with 3-D particle-in-cell code simulations. Practical implications of the findings are discussed, including the effects of a DC magnetic field used to suppress the multipactor. [1] J.G. Power, W. Gai, et al., Phys. Rev. Lett. 92, 164801 (2004). [2] O.V. Sinitsyn, G.S. Nusinovich, and T.M. Antonsen, Phys. Plasmas 16, 073102 (2009); see also Proc. 2010 AACW. [3] R.A. Kishek, "Ping-Pong Modes: A New Form of Multipactor," Phys. Rev. Lett. 108, 035003 (2012).	

Name of submitting author	Dr. Sergey Kuzikov
Institution	Institute of Applied Physics, Russian Academy of Sciences
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Abstract Title	**RF Undulator for Compact X-Ray SASE Source of Variable Wavelength**
Author/Affiliation listing	**S.V. Kuzikov** / Institute of Applied Physics, 46 Ulyanov St., Nizhny Novgorod, Russia and Omega-P, Inc., New Haven, CT, USA Y. Jiang / Yale University, New Haven, CT, USA A.A. Vikharev, J.L. Hirshfield /Yale University, New Haven, CT, USA and Omega-P, Inc., New Haven, CT, USA T.C. Marshall / Columbia University, New York, NY and Omega-P, Inc., New Haven, CT, USA
Abstract	A room-temperature RF undulator to produce ~1 nm wavelength radiation using relatively low energy electrons is considered. The necessary short electron bunches with energy in the range 0.1-1 GeV could be produced by a conventional linac, or using a compact petawatt laser injecting pulses into plasma bubbles.
Summary	
The design features of RF undulator include an effective undulator period of 0.45 cm, an undulator parameter of K = 0.4, and an effective field length of 50 cm. These parameters could be realized using a multi-MW RF power amplifier to drive the undulator (e.g., the 34 GHz pulsed magnicon at Yale or a 30 GHz gyroklystron at IAP). Design of an undulator is based on the use of long high-Q cavities. Two designs were considered that avoid problems with a co-propagating wave destroying beam optics and spectra of scattered radiation: a dual-mode cylindrical cavity [TE01 (counter propagating) - TE02 (co-propagating)] with an off-axis electron beam; and a TM11 mode near cut off cavity with an on-axis beam. Both designs provide low surface fields, low pulse heating effects and require 10-30 MW power. Usually an injection of the electron bunches in an undulator should be synchronized with a phase of RF radiation. In our designs field distributions with smooth tapers on ends allow to avoid problems with synchronization. Short (10's of fs) electron bunches could be produced using petawatt laser pulsed injection into plasma bubbles, as has already been demonstrated [1]. [1] A.V Korzhimanov, A A Gonoskov, E.A Khazanov, A.M Sergeev. Horizons of petawatt laser technology, 2011 Phys.-Usp., Vol. 54, No.1 (9) http://iopscience.iop.org/1063-7869/54/1/R03;jsessionid=B3A778DBA1E751295A424B8FE7B51C96.c3 *Supported in part by US DoE.	

Name of submitting author	Mr. Joshua McNeur
Institution	UCLA
Email	josh.mcneur@gmail.com
Abstract Title	**A monolithic relativistic electron beam source based on a dielectric laser accelerator structure**
Author/Affiliation listing	**J. McNeur**, N. Carranza, K. Hazra, G. Liu, E. Sozer, G. Travish UCLA, Los Angeles, CA Y. Hairong UESTC, Chengdu, Sichuan R. Yoder Manhattanville, Purchase, NY
Abstract	Work towards a monolithic device capable of producing relativistic particle beams within a cubic-centimeter is detailed. We will discuss the Micro-Accelerator Platform (MAP), an optical laser powered dielectric accelerator as the main building block of this chip-scale source along with a field enhanced emitter and a region for sub-relativistic acceleration.
Summary	
There has been an ongoing effort at UCLA to design a monolithic device capable of producing an electron beam with an energy around 1 MeV within a very small space. The Micro-Accelerator Platform (MAP), a resonant laser accelerator, can be combined with an emitter to produce a monolithic optical-scale dielectric device that produces electrons at >1 MeV with a total interaction length of 1 mm. Electrons at ~25 keV are produced via field-enhanced emission from a thin wedge and injected into a planar accelerator structure. This device then requires a modified MAP region that “captures” low-energy emitted electrons and accelerates them to velocities near c, at which point a relativistic structure can be employed. We present simulations and analysis of both the subrelativistic and relativistic structures, including resonances and particle dynamics. A highly efficient laser coupling scheme will be described, in which between >70 % of laser power enters the cavity resonance. Detailed simulations of the emitting wedge and emitted current will be presented. Applications including use as an injector for a light source or a collider will be briefly mentioned.	

Name of submitting author	Mr. Brian Munroe
Institution	MIT Plasma Science and Fusion Center
Email	bmunroe@mit.edu
Abstract Title	**High-gradient Testing of Photonic Band-gap (PBG) Accelerator Structures at 11 GHz and 17 GHz**
Author/Affiliation listing	**Brian Munroe**, Michael Shapiro, Richard Temkin MIT PSFC; Roark Marsh, LLNL; Dian Yeremian, Valery Dolgashev, Sami Tantawi SLAC
Abstract	We present results from testing of high-gradient photonic band-gap (PBG) accelerator structures at 11 GHz and 17 GHz. An improved PBG structure at 11 GHz demonstrated high-gradient, low breakdown probability performance comparable to an undamped disc-loaded waveguide structure.

Summary

Photonic Band-gap (PBG) structures continue to be a promising area of research for future accelerator structures. High repetition rate testing of an improved PBG structure at 11 GHz at SLAC demonstrated simultaneous high-gradient and low breakdown probability operation of a structure with intrinsic higher-order mode (HOM) damping. In this improved design the rods in the inner row have an elliptical cross-section, which reduces the surface magnetic field on the rods relative to previous round-rod PBG structures tested at SLAC, thereby reducing the Ohmic heating of the rod surface in an effort to reduce pulsed heating damage. This improved PBG structure was tested experimentally such as to avoid excessively high breakdown rates and surface temperature rise; the structure achieved greater than 100 MV/m gradient at a breakdown probability of less than 10-3 per pulse per meter for 150 ns pulses.

PBG structure with all the rods having a circular cross-section has been designed for testing at 17 GHz at MIT. This structure is expected to reach a gradient of at least 100 MV/m and will utilize novel diagnostics, including fast camera imaging and optical spectroscopy of breakdowns.

Name of submitting author	Dr. Gregory Nusinovich
Institution	IREAP, University of Maryland, College Park, MD 20742-3511
Email	gregoryn@glue.umd.edu
Abstract Title	**Role of RF electric and magnetic fields in melting micro-particles in accelerating structures.**
Author/Affiliation listing	**G. S. Nusinovich**, Y. Han, and T. M. Antonsen, Jr.
Abstract	Metallic micro-particles may appear in the accelerating structures for a number of reasons. These particles can absorb microwave fields and be heated and melted. The theory describing the field emission of a particle and its heating is developed. This effect is compared with the effect of the RF magnetic field.

Summary

Metallic micro-particles may appear in accelerating structures for a number of reasons; one of the most obvious is the erosion of input irises in high intensity fields. Such micro-particles can absorb microwave fields. Typically, in this process the RF magnetic field plays the most important role, and this absorption is the strongest when the particles have sizes on the order of the skin depth. The effect of RF magnetic fields in the heating of such particles in single-pulse regimes was studied first [1]. Then, the operation in rep-rate regimes was analyzed [2]. In the present study, the theory is developed that describes the emission from micro-particles in strong RF electric fields. This emission may appear in micro-particles having some sharp ends causing significant field magnification. We analyzed this effect by considering the model of a prolate spheroid with an arbitrary ratio of semi-axes. First, the dependence of the field magnificat ion at the apex of such a spheroid on the height-to-radius ratio was studied. Then, the field emitted current and the subsequent joule heating of a micro-particle by this current had been calculated (with the account for thermal emission). This heating was analyzed in single-shot and rep-rate regimes and, in the latter case, also the cooling due to black-body radiation between subsequent pulses was taken into account. The temperature rise due to this effect is compared with the temperature rise caused by the RF magnetic field. The treatment is illustrated with an example of a present-day high-gradient SLAC structure.

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Name of submitting author	Mr. Edgar Peralta
Institution	Stanford University / SLAC
Email	eperalta@stanford.edu
Abstract Title	**Design, Fabrication and Testing of a Fused-Silica Dual-Layer Grating structure for Direct Laser acceleration of electrons**
Author/Affiliation listing	**E. A. Peralta** , R. L. Byer / Stanford University, Stanford CA 94305, USA R. J. England, K. Soong, Z. Wu, B. Montazeri / SLAC, Menlo Park, CA 94025, USA
Abstract	We describe our progress towards the first demonstration of direct laser acceleration of electrons using a fused-silica grating structure. The structure was designed via 2D-FDTD and 3D-FEFD simulations, fabricated at the Stanford Nanofabrication facility, and tested with a 60MeV beam at the Next Linear Collider Test Accelerator at SLAC.

Summary

The transmission-based dual layer grating structure first proposed in
excellent candidate structure for a first demonstration of a laser-driven electron
accelerator due to the simple coupling of
the inherent group -
based
the structure to be driven by ultrashort high-power laser
storage (no optical Q) which reduces the
significantly higher
fabrication approaches, one monolithic, and the other
presented in Ref. (2) and carried out
Stanford -up Nanofab
monolithic approach, and guided by simulations showing
misalignment of the two gratings reduces
opted to focus on the -wafer-bonding approach. This fabrication method, in which one
grating layer is etched into a pre-existing trench that determines the
yielded the first ever complete structure with an -8
Saphire laser wavelength), and 400nm
are diced into individual samples with channels
electron beam to the structure
the Next
No
design structures with larger gaps of .8 um and 1.2 um.
aperture structures required further
trenches, but
was observed early in 2012.

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Name of submitting author	Prof. James Rosenzweig
Institution	UCLA Dept. of Physics and Astronomy
Email	rosen@physics.ucla.edu
Abstract Title	**The GALAXIE Project**
Author/Affiliation listing	**J. Rosenzweig**, E. Arab, G. Andonian, K. Fitzmorris, P. Hoang, G. Marcus, P. Musumeci, B. Naranjo, B. O'Shea, F. O'Shea, S. Putterman, K. Roberts, A. Valloni, UCLA S. Tantawi, SLAC I. Jovanovic, Penn State A. Murokh, A. Ovodenko, RadiaBeam Techologies V. Yakimenko, I. Pogorelsky, BNL
Abstract	We describe a broad project to develop a table-top X-ray FEL based on udielectric acceleration and electromagnetic undulators: GV/m AcceLerator And X-ray Integrated Experiment (GALAXIE). We discuss a biharmonic photonic TW structure, 200 micron wavelength electromagnetic undulators, 5 micron laser development, ultra-high brighness electron beam generation, and quantum-limit FEL operation.
Summary	
Pending	

Name of submitting author	Prof. James Rosenzweig
Institution	UCLA Dept. of Physics and Astronomy
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Abstract Title	**Simultaneous Transverse and Longitudinal Stability in a Laser-driven Dielectric Accelerator**
Author/Affiliation listing	B. Naranjo**, J. Rosenzweig**, A. Valloni, UCLA
Abstract	In a wide-beam Cartesian geometry, laser-driven, high field accelerators Earnshaw's Theorem indicates that simultaneous transverse and longitudinal stability is forbidden. This is overcome in second order by use of strong nonsynchronous spatial harmonic focusing in a biharmonic structure. Photonic structure, external coupling, and beam dynamics simulation and analysis are presented.
Summary	
Pending	

Name of submitting author	Dr. Paul Schoessow
Institution	Euclid Techlabs
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Abstract Title	**Dielectric Structures: Collimation and Nonlinear THz Source Applications**
Author/Affiliation listing	**Paul Schoessow**, Alexei Kanareykin (Euclid Techlabs) Stanislav Baturin (St Petersburg Electrotechnical Institute)
Abstract	The wakefield accelerator concept has produced a number of interesting spinoffs. Two will be discussed here. The possibility of reducing wakefields in CLIC and ILC beam delivery systems using dielectric collimators employing novel damping techniques. Second, progress towards a ferroelectric based THz nonlinear frequency multiplier structure will be presented.
Summary	
Advances in dielectric materials and components have arisen in the context of research into new particle acceleration techniques, particularly those related to the dielectric wakefield accelerator. In this paper we focus on two of these applications, collimation and nonlinear THz generation. additional research on wakefield reduction in the collimator sections. New materials and new geometries have been considered recently. Dielectric collimators for the CLIC Beam Delivery System have been discussed with a view to minimize the BDS collimation wakefields. We present a number of dielectric collimator concepts for the linear collider; cylindrical and novel layered planar collimators for the CLIC parameters are considered. We show results of simulations of wakefields in these collimator configurations. dielectric wakefield accelerator, electromagnetic fields excited by an electron beam in a dielectric structure are used to accelerate a second, trailing beam to high energy. Energy can be efficiently extracted from the beam in this manner and thus the accelerating structure can also be used as an RF source, with frequencies extending into the THz. New ferroelectric materials, particularly Barium-Strontium Titanates exhibit potentially transformational uses in this technology. We discuss the applications to nonlinear frequency multiplication of the wakefield in a ferroelectric structure. for experimental tests of prototype collimator systems and nonlinear THz structures at Facilities for Accelerator Science and Experimental Test Beams (FACET) at SLAC.	

Name of submitting author	Michael Shapiro
Institution	MIT Plasma Science and Fusion Center
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Abstract Title	**Overmoded Dielectric and Metallic Photonic Bandgap Structures**
Author/Affiliation listing	Plasma Science and Fusion Center, Massachusetts Institute of Technology, Cambridge, MA 02139
Abstract	We report the theory and cold test results from overmoded photonic band gap structures using dielecrtric or metallic rods. The overmoded structures can be used in accelerators or high power microwave sources.
Summary	
Overmoded cavities built as defects in dielectric and metallic photonic bandgap (PBG) structures have found interesting applications at high power microwaves because of higher breakdown field strength and selective mode excitation provided by the PBG structure. An electron beam of larger current can be used in an accelerator application because of the operation in a higher order mode. The design and planned test of a dielectric PBG structure based accelerator cavity operating in the higher order mode TM02 is presented. The fundamental mode TM01 is not confined in the cavity. This mode suppression feature can be provided only in dielectric structures. Dielectric PBG structures are also advantageous for dielectric wakefield accelerators. microwave sources (such as klystrons), the excitation of a higher order mode (TM02) can be selective using an annular electron beam of larger radius. The output cavity of the klystron can be designed as a metallic PBG cavity in which the TM02-like mode is confined and other modes in the vicinity are not confined (TM22, for example). Because the cavity is highly overmoded, higher selectivity of the TM02 mode and higher discrimination of other modes must be provided by the PBG structure. This high selectivity can be provided for the wave propagating in the PBG structure at the frequency that corresponds to the Dirac point. An example of a TM02-like mode in a PBG structure at the Dirac point is presented.	

<table>
<tr><td>Name of submitting author</td><td>Prof. Gennady Shvets</td></tr>
<tr><td>Institution</td><td>The University of Texas at Austin</td></tr>
<tr><td>Email</td><td>gena@physics.utexas.edu</td></tr>
<tr><td>Abstract Title</td><td>Prism-coupled surface wave accelerator based on silicon carbide</td></tr>
<tr><td>Author/Affiliation listing</td><td>Burton Neuner III, Dmitriy Korobkin, Kamil Alici, Vladimir Khudik, and Gennady Shvets,
Department of Physics, University of Texas at Austin, 1 University Station C1500,
Austin, Texas 78712, USA</td></tr>
<tr><td>Abstract</td><td>A compact, solid-state accelerating structure consisting of two SiC layers epitaxially grown on Si slabs and separated from each other by a subwavelength acceleration channel will be described. Longitudinal (accelerating) and transverse (deflecting) surface modes are experimentally excited by a CO2 laser and characterized by angle-resolved spectroscopy.</td></tr>
<tr><td colspan="2">Summary</td></tr>
<tr><td colspan="2">I will describe [1] a compact, solid-state accelerating structure based on surface waves is proposed and
epitaxially grown
acceleration channel, is shown to
(deflecting) surface modes. Both modes
performing angle-resolved spectroscopy with a wavelength-tunable carbon dioxide
laser. Phase velocities of superluminous and subluminous
demonstrated, paving the way for tabletop charged particle acceleration. The same structure can be used for optical characterization of ultrashort electron
generate longitudinal and transverse Cherenkov radiation. Theoretical calculations of Cherenkov wakes excited in the structure by a short electron bunch will be presented, and preliminary results from the ATF beamline will be reported.

[1] Burton Neuner III,1 Dmitriy Korobkin,1 Gabriel Ferro,2 and Gennady Shvets, "Prism-coupled surface wave accelerator based on silicon carbide", PHYSICAL REVIEW SPECIAL TOPICS - ACCELERATORS AND BEAMS 15</td></tr>
</table>

Name of submitting author	Dr. Evgenya Simakov
Institution	LANL
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Abstract Title	**An Update on the DOE Early Career Project on Photonic Band Gap Accelerator Structures**
Author/Affiliation listing	**Evgenya I. Simakov**, W. Brian Haynes, Michael A. Madrid, Frank P. Romero, Tsuyoshi Tajima, and Walter M. Tuzel Los Alamos National Laboratory Chase H. Boulware, Terry L. Grimm Niowave, Inc.
Abstract	We will present an update on the 2010th DOE Early Career project on photonic band gap (PBG) Accelerator Structures. The two goals of the project are demonstration of the high gradient performance of SRF PBG resonators and demonstration of wakefield suppression in a room-temperature traveling wave PBG accelerator.
Summary	
It has been long recognized that PBG structures have great potential in reducing long-range wakefields in accelerators. The first ever demonstration of acceleration in room-temperature PBG structures was conducted at MIT in 2005. Since then, the importance of that device has been recognized by many research institutions. Using PBG structures in superconducting particle accelerators may allow operation at higher frequencies and significantly higher beam luminosities thus leading towards a completely new generation of colliders for high energy physics. However, the technology of fabrication of PBG accelerator cells from niobium has not been well developed to date. Here we will report the results of our efforts to fabricate a 2.1 GHz PBG cell and to test it at high gradients in a liquid helium bath at the temperature of 2 Kelvin. The high gradient performance of the cell will be evaluated and the results will be compared to simulations with the CST Microwave Studio. a room-temperature traveling-wave photonic band gap (PBG) accelerating structure is long overdue. The Argonne Wakefield Accelerator (AWA) test facility at the Argonne National Laboratory represents a perfect site where this evaluation could be conducted with a single high charge electron bunch and with a train of bunches. We will present the design of the accelerating structure to be tested at AWA in the near future. The structure will consist of sixteen 2pi/3 PBG cells, including two coupler cells. We will also present the results of the initial cold-testing of the few sample cells and a plan for the beam test. This work is supported by the U.S. Department of Energy (DOE) Office of Science Early Career Research Program.	

Name of submitting author	Dr. Evgenya Simakov
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Abstract Title	**Pushing the Gradient Limitations of Superconducting Photonic Band Gap Structure Cells**
Author/Affiliation listing	**Evgenya I. Simakov**, W. Brian Haynes, Sergey S. Kurennoy, James F. O'Hara, Eric F. Olivas, Dmitry Yu. Shchegolkov Los Alamos National Laboratory
Abstract	We will present a design of a superconducting photonic band gap (PBG) accelerator cell with specially shaped rods which reduces the peak surface magnetic fields and at the same time to preserves the effectiveness of the PBG structure for suppression of the higher order modes.
Summary	
It has been long recognized that PBG structures have great potential in reducing long-range wakefields in accelerators. The first ever demonstration of acceleration in room-temperature PBG structures was conducted at MIT in 2005. Since then the importance of that device has been recognized by many research institutions. The effectiveness of PBG structure for suppression of long-range wakefields is especially beneficial for superconducting electron accelerators for high power free-electron lasers (FELs), which are intended to provide high current continuous duty electron beams. Using PBG structures to reduce the prominent beam-breakup phenomena due to HOMs will allow significantly increased beam-breakup thresholds, and consequently will allow the increase of the frequency of SRF accelerators and the development of novel compact high-current accelerator modules for FELs. High gradient limitations of PBG resonators and the optimal arrangement of the wakefield couplers will be discussed in details in this presentation. We will present a design of an SRF PBG accelerator cell that reduces the peak surface magnetic fields by 40 per cent as compared to the design with a regular structure of round rods. This resonator will be fabricated and tested for high gradient limitations within the next year. This work is supported by the Department of Defense High Energy Laser Joint Technology Office through the Office of Naval Research.	

Name of submitting author	Dr. Oleksandr Sinitsyn
Institution	IREAP, University of Maryland
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Abstract Title	**3D Monte-Carlo Simulations of Multipactor in Dielectric-Loaded Accelerating Structures**
Author/Affiliation listing	**O. V. Sinitsyn**, G. S. Nusinovich and T. M. Antonsen, Jr. Institute for Research in Electronics and Applied Physics, University of Maryland
Abstract	Multipactor (MP) is a severe problem in modern RF and microwave systems. In this work the authors present results of numerical studies of MP in dielectric-loaded accelerating (DLA) structures. Comparison with experimental data is shown and a new method of MP suppression by using an external magnetic field is discussed.

Summary

Multipactor (MP) is known as an avalanche growth of the number of secondary electrons emitted from a solid surface in the presence of an RF field under vacuum conditions. MP may occur in various microwave and RF systems and usually results in severe degradation of their performance. Therefore theoretical and experimental studies of MP aimed at finding methods of its suppression are of great importance. This work is focused on the theoretical analysis of MP in dielectric-loaded accelerating (DLA) structures. It was motivated by extensive studies of such structures jointly done by Argonne National Laboratory (ANL) and Naval Research Laboratory (NRL) [1-3]. We aimed at developing a simple self-consistent model of MP that would explain the experimental results obtained during those activities. First, we developed a 2D self-consistent model of MP [4] which demonstrated a good agreement with the experimental data for the structures of larger diamete r but showed discrepancy for the ones of smaller diameter [5]. Recently we developed a new 3D Monte-Carlo model of MP [6] and started its benchmarking against available experimental data. Results of such comparative analysis are presented in this work. We also analyze the effect of external static magnetic field which was recently proposed as a new method for MP suppression [7].

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[7] C. Jing, Joint MAP & High Gradient RF Collaboration Workshop, Nov. 1-4th, 2011,

Lawrence Berkeley National Laboratory, Berkeley, CA.

Name of submitting author	Ken Soong
Institution	Stanford University\SLAC National Accelerator Laboratory
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Abstract Title	**Diagnostic, Focusing, and Deflecting Direct Laser Accelerator Structures**
Author/Affiliation listing	**Soong**, Colby, Byer, England, Peralta, McGuinness
Abstract	Recent technological advances has made possible the realization of the first laser-driven particle accelerator structure to be fabricated lithographically. However, a complete accelerator requires more than just accelerating structures. In this talk we will present three other quintessential elements: the focusing structure, the deflecting structure, and the diagnostics structure.

Summary
This talk/poster will focus mainly on the deflecting, focusing, and diagnostic components of a laser-driven dielectric accelerator. We will briefly present the concept behind the laser-driven dielectric grating accelerator structure, as a motivation for the other three designs. The main appeal of the deflection and focusing structure designs is their compatibility with the current grating accelerator fabrication process, which means that all three of these components could be fabricated simultaneously on a wafer. This compatibility of fabrication is likely to be a necessity for a realistically achievable high-energy dielectric accelerator. Both the deflecting and the focusing structures have been simulated in HFSS and the simulations show deflection and focusing forces which are 2 to 3 orders of magnitude larger than their traditional counterparts. The third component is a grating-type BPM, which has the unique ability to map a particle beam position to a measurable wavelength. By encoding the position as a wavelength, we remove any amplitude dependence; resulting in a significantly more robust and sensitive device. When coupled with an optical spectrometer, this grating-type BPM is capable of resolving a particle beam position to sub-nanometer precision.

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Abstract Title	**Laser Damage Threshold of Optical Materials for Direct Laser Accelerators**
Author/Affiliation listing	**Soong,** Colby, England, Byer, Peralta, McGuinness
Abstract	The laser-damage threshold is a fundamental limit for any dielectric laser-driven accelerator and is set by the material of the structure. We present a model of the laser damage mechanism, along with our damage threshold data of various materials, most of which have not been previously characterized in the picosecond-regime.
Summary	
This talk will focus on the laser damage mechanism and laser damage threshold of dielectric materials from ultra-fast (<1 ps) laser pulses. We will begin with our motivation for the work from the standpoint of developing better dielectric-based laser-driven accelerator structures. We will then present our simple model for the laser damage mechanism, which relates the laser damage threshold to the electric properties of the material, as well as the wavelength of the laser. Briefly stated, the laser pulse will ionize electrons in the material, which then form a plasma. This plasma will oscillate at a certain plasma frequency, which is dependent on the density of ionized electrons. When the plasma frequency matches the laser frequency then you will have resonant oscillations, resulting in a rapid absorption of energy and ultimately damage. model, we will then describe our laser damage threshold experimental setup, including the main operating principles and various diagnostics and characterization instruments. Finally, we will present the data acquired using our damage threshold setup, which will include: data from a typical measurement (to show key characteristics of these measurements), data from a wavelength vs. damage threshold measurement (on silicon) to support our laser damage model, and finally damage threshold measurements of various optical materials commonly found in nanofabrication.	

Name of submitting author	Dr. James Spencer
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Abstract Title	**Study of 2D Dielectric PBG Structures for Accelerator Applications**
Author/Affiliation listing	Joel England, Cho Ng, Robert Noble, **Jim Spencer** and Ziran Wu (SLAC)
Abstract	Because dielectrics have higher breakdown thresholds than metals we have collaborated with Incom, Inc to produce 2D hollow core PBG crystals supporting TM01-like modes with high gradients. Three structures have bandgaps and modes ranging from 1.6-7.5 microns based on FTIR measurements. These agree well with simulations using CUDOS and BandSolve.

Summary

Since the first discussions of dielectric Photonic Band Gap (PBG) crystalline structures, there have been very few practical applications developed even in the
presumably because of the difficulty of justifying their high costs and the hard problems of design simulation and fabrication. However, because
breakdown fields than conventional metals there would appear to be any number of intriguing possibilities especially when one considers
and structural types there are to choose from. For accelerators, dielectric structures based on fused silica can have a factor of twenty l
metallic RF based on OFHC Cu. This is a good illustration of the costs to be saved from miniaturization. For such reasons
design and produce 2D hollow core PBG structures that support TM01-like accelerating modes. To date, we have designed,
multiple bandgaps with accelerating modes that cross the speed-of-light line at wavelengths ranging from 1.6-7.5 microns.
measured their bandgaps and their widths versus frequency and compared these to the simulations of the as-built structures using
results based on detailed measurements of the fabricated structures after they had been cut and polished down to lengths of
the lowest three bandgaps crossing the light line at 1.6, 1.9 and 2.1 microns so that they can be driven by known t lasers. We are now
modes.

*This is a collaboration with Incom Inc. of Charlton, MA funded by DOE grant DE-SC0000893.

Name of submitting author	Dr. Peter Stoltz
Institution	Tech-X Corp
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Abstract Title	New approaches to multipacting modeling with application to high gradient structures
Author/Affiliation listing	**Peter Stoltz**/Tech-X Chet Nieter/Tech-X
Abstract	We discuss a new approach to multipacting modeling that allows modeling of multiple power levels in one simulation. This allows one to quickly scan power levels to find levels that may be susceptible to multipacting. We demonstrate this capability on a coax damping structure designed for high gradient crab cavities.
Summary	
We discuss a new approach to multipacting modeling that allows modeling of multiple power levels in one simulation. This allows one to quickly scan over power levels to find levels that may be susceptible to multipacting. We demonstrate this capability on a coax damping structure designed for high gradient crab cavities.	

Name of submitting author	Faya Wang
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Abstract Title	**Local high electric field breakdown study**
Author/Affiliation listing	**Peter Stoltz**/SLAC, Zenghai Li/SLAC
Abstract	This paper presents an experimental setup for high RF electric field breakdown study at X-band. The setup is composed of a WR90 waveguide and a pin inserted into the waveguide on the E-plane. It is an ideal setup to study the dependence of rf breakdown dependence on power flow.
Summary	
Experiments from NLC accelerator structures have shown a structure that requires more power to achieve the same gradient tends to have a higher breakdown rate. Significant efforts and progresses have been made to understand the dependence of rf breakdown on the input power, E and B field, such as experiments with waveguides and single cell cavities. However, for such a high power structure, it usually has larger group velocity, higher peak electric and magnetic fields. Therefore, it is hard to draw a clear conclusion on the correlation between breakdown rate and power flow. With the current setup of local high field enhancement around pin head, it is able to isolate power flow from group velocity and magnetic field. The rf design presented here will allow to vary the power flow by a factor of 10 to achieve the same electric field while maintaining the constantly magnetic field nearly around the pin head as well as the constantly group velocity of the structure.	

Name of submitting author	Faya Wang
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Abstract Title	**Dark Current Related Breakdown Mechanism**
Author/Affiliation listing	**Peter Stoltz**/SLAC, Lixin Ge/SLAC
Abstract	A model about the dark current associated breakdown mechanism was established, which was used to study the x-band and L band (muon cavity) breakdown . Some preliminary results from the model are presented in this paper.
Summary	
All the experiments from muon-cooling cavities have shown that the damage or gradient reducing was directly related with the external magnetic field increasing. Field emitted electrons from local high field area were believed to be causing the problem. A model about the field emission associated breakdown mechanism was studied. With further study, we found that not only the muon cavity breakdown could be understood with the model, but also x-band structure breakdown.	

Name of submitting author	Ziran Wu
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Abstract Title	**Coherent Terahertz Radiation Source at FACET**
Author/Affiliation listing	**Ziran Wu**, SLAC Alan Fisher, SLAC
Abstract	This paper presents preliminary characterization of the terahertz pulses generated by the FACET electron beam via coherent transition radiation. The measured THz frequency content spans from 0.25 THz to 2.3 THz and peaks at around 0.5 THz, with 0.69 mJ collected total energy per pulse.

Summary

The Facility for Accelerator science and Experimental Tests (FACET) at SLAC provides a high charge, high peak current, sub-picosecond bunched electron beam that is ideal for 0.1 to 2 THz radiation generation via coherent transition radiation. The intense EM fields generated are orders of magnitude stronger than those available from laboratory tabletop sources, and open up opportunities for nonlinear THz experiments. This paper presents preliminary characterization of the terahertz pulses generated by the FACET electron beam. A one-micron thick Titanium foil has been inserted into the beam path and the radiated photons collected. Michelson spectroscopy yields THz frequency content spanning from 0.25 THz to 2.3 THz and peaked at around 0.5 THz. Multiple scans at different bunch compression show a monotonic increase of the peak radiation frequency as the electron bunch gets shorter. Several filtering effects are identified in the spectrum, including the water vapor absorption, the detector response, and the low frequency roll-off due to diffraction limit and skin depth of the foil. Using the Kramers-Kronig relation, the temporal profile of the THz pulse is reconstructed from the power spectrum indicating a ~ 4 picosecond main pulse followed by a long oscillating tail due to the water absorption lines and detector response. Knife-edge scans measure a 4.4 x 4.8 mm2 transverse spot size at the focal point of the THz optical path. The total collected energy per pulse is 0.69 mJ measured by a Joulemeter. Fitting this total energy to the spatiotemporal profile of the THz pulse yields peak e-field amplitude of 1.5 MV/cm.

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Name of submitting author	Ziran Wu
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Abstract Title	**Disk-Loaded RF Waveguide Matching Techniques Applied to Silicon Woodpile Accelerator**
Author/Affiliation listing	**Ziran Wu**, SLAC Cho Ng, SLAC Sami Tantawi, SLAC
Abstract	Silicon woodpile photonic crystal provides three-dimensional dielectric waveguide system for laser driven acceleration. Several coupler schemes developed for multi-cell RF cavity haven been adapted in the woodpile accelerator design, to achieve high coupling efficiency and traveling-wave launching in the woodpile waveguide. This paper will introduce these schemes and simulation results.
Summary	
Silicon woodpile photonic crystal provides a three-dimensional dielectric waveguide system for high-gradient laser driven acceleration. The woodpile waveguide is periodically loaded in the longitudinal direction; therefore simple cross-sectional mode profile matching is not sufficient to launch the accelerating mode appropriately and will result in significant scattering loss. Hinted by the common nature of longitudinal periodicity between disk-loaded waveguide and woodpile waveguide, several coupler design schemes developed for multi-cell RF cavity are implemented in the woodpile accelerator design. Among them there are the travelling-wave match method based on S-matrix, the periodic VSWR method, and the TE-to-TM coupling iris design. This paper presents design procedures and simulation results using these methods. According to simulations, nearly 100% power transmission between SOI and woodpile waveguides with a traveling-wave match is achieved with a specially designed mode-launching coupler. Constructed by silicon rods extruding into the defect waveguide, the coupling iris provides necessary transition from TE mode to TM accelerating mode, also with negligible coupling loss.	

Name of submitting author	Dr. Rodney Yoder
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Abstract Title	**Experimental and Simulated Results of Resonance, Particle Dynamics, and Particle Transmission in the Micro-Accelerator Platform**
Author/Affiliation listing	**R. Yoder** Manhattanville College, Purchase, NY G. Liu, K. Hazra, J. McNeur, E. Sozer, G. Travish UCLA, Los Angeles, CA
Abstract	We describe recent experimental results with the Micro-Accelerator Platform (MAP), a slab-symmetric dielectric laser accelerator (DLA), and use simulation to model ongoing acceleration tests and particle dynamics at SLAC E-163, including the quality of resonances produced in recently fabricated MAP structures. Optical characterization of those structures will also be discussed.

Summary

The Micro-Accelerator Platform (MAP) is an optical-scale slab-symmetric dielectric resonant cavity designed to impart 1 MeV of kinetic energy to electrons over a distance of 1 mm. A Ti:Sapphire laser couples into the MAP to create a standing wave with a periodicity designed to synchronously accelerate electrons at an energy gradient of 1 GeV/m. Simulations and analysis of resonances in MAP structures have been described at previous AAC workshops; here we emphasize preliminary experimental results, and analyze and simulate particle dynamics relevant to these tests at SLAC's E-163 facility. In particular, transmission of electrons through the vacuum channel of the MAP and optical characterization of the MAP are discussed in detail. Challenges with fabrication and experimental characterization are also presented.