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Directed Energy Weapons (DEWs): A Bibliography

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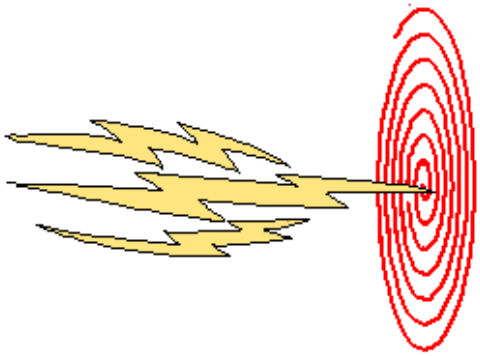

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DOCUMENTS, THESES AND TECHNICAL REPORTS

Although there are a number of very relevant reports issued with distribution limitations (e.g. FOUO or DOD only), due to the public nature of this bibliography, this section includes unclassified/unlimited distribution references only. Abstracts were taken from the DTIC [Defense Technical Information Center] and NTIS [National Technical Information Service] databases and were written by the authors of the documents cited or by the abstracting services from which the citations were generated, not by the authors of this bibliography.

Abbas, G.L. "Photonics Technology for Avionic Systems." In: AIAA/IEEE Digital Avionics Systems Conference. 12th DASC. Fort Worth, TX 25-28 October 1993. New York, NY: IEEE, 1993. p. 349-356.

Abstract: Over the last several years, it has become widely recognized that electromagnetic interference (EMI), electromagnetic pulse (EMP), high-intensity radio frequency (HIRF), and new threats, such as directed energy weapons, can jeopardize the flight safety of vehicles equipped with fly0by-wire (FBW) systems, unless adequate shielding precautions are taken. This leads to weight penalties which can be avoided through implementation of fly-by-light (FBL) systems.

Abbas, G.L et al. "Photonics Technology for Avionic Systems." Seattle, WA: Boeing Defense & Space Group, 1994. In: Laser Diode Technology and Applications VI, Los Angeles, CA, 25-27 January 1994. Proceedings of the SPIE - The International Society for Optical Engineering, vol. 2148, p. 280-291.

Abstract: Over the last several years, it has become widely recognized that electromagnetic interference (EMI), electromagnetic pulse (EMP), high-intensity radio frequency (HIRF), and new threats, such as directed-energy weapons, can jeopardize the flight safety of vehicles equipped with fly-by-wire (FBW) systems, unless adequate shielding precautions are taken. This leads to weight penalties which can be avoided through implementation of fiber-optic systems.

Acebal, R. et al. Science Applications Int. Corp., McLean, VA, 1987. "An integrated architecture analysis for affordability assessment (SDI)." In: Proceedings of the 1987 Summer Computer Simulation Conference, Montreal, Quebec, Canada, 27-30 July 1987. p. 958-963.

Abstract: Deals with developing a method of selecting strategic defense system (SDS) designs from the multitude of options available in the areas of weapons; surveillance, acquisition, tracking and kill assessment; and battle management, command, control and communication. The defense system designer must seek out affordable concepts which balance the technology risk between subsystems. Hence, the problem entails seeking out a well defined methodology and analysis technique which allows the defense planner to construct attractive concepts that offer the required balance between tiers and subsystems. The Strategic Defense Simulation-Design To (SDS-DT) code provides the tool by which the system designer may: (1) design a family of defense system architectures each of which achieves a specified level of performance, (2) compute figures of merit allowing each architecture option to be evaluated in terms of technical risk, cost and sensitivity to countermeasures, (3) show the connection between the top-down derived requirements with the bottom-up technology derived capabilities, and (4) utilize a code which is user friendly and operates on a personal computer. The SDS-DT code has been used to perform a number of closely related studies for strategic defense systems. The results presented show analyses generated to evaluate the impact of a nuclear precursor and direct ascent anti-satellite attacks on leakage as well as the increment on total life cycle cost to maintain constant leakage. A target lethality study shows the effect of kill probability on leakage for

directed energy weapons. The model's capability to conduct optimization studies on weapon parameters such as burnout velocity for rocket propelled interceptors is then presented. Finally, the model is used to show the effects of countermeasures such as fast burn boosters on leakage.

“Active Two Phase Cooling of Optics.” Final technical report. January 22, 1988 - July 22, 1991. Progress report. Lancaster, PA: Thermacore Inc., 1991. 8p.

Abstract: Two phase cooling of a higher powered laser optics offers a significant potential to advance the state-of-the-art in laser mirror cooling. Significant improvements can be achieved through the transfer of heat via working fluid phase change rather than specific heat capacity. These benefits include reduced jitter, and reduced electrical power consumption. In one actively pumped two phase cooling scheme, a saturated liquid is mechanically pumped into a porous metal layer under the mirror face where a fraction of the fluid is vaporized. The vapor-liquid mixture then leaves the face area and flows to a condenser. The condensate recirculates back to the mirror in a closed loop process. Because the working fluids have high latent heats of vaporization compared to their liquid heat capacities, a significant reduction in flow rate and pressure drop is possible. Analytical and experimental work has shown that a favorable combination of low distortion and low jitter is achievable with this approach. Also, since two phase heat transfer coefficients increase with increasing heat flux, a two phase cooled optic will achieve a lower distortion under non-uniform beam profiles. Jitter data were collected at absorbed heat fluxes up to 80 W/cm (sup 2) using a molybdenum demonstration mirror with methylamine coolant at 20(degrees)C. Low distortion coefficients were used as a design goal for this program at an absorbed heat flux up to 100 W/cm(sup 2). A demonstration mirror was fabricated and tested for thermal/optical performance. Thermal performance levels in excess of 100 W/cm (sup 2) were demonstrated. Tests conducted at the TDTF showed thermal distortion coefficients at or below the design goal for absorbed heat fluxes up to levels in excess of 100 W/cm(sup 2). No other cooling approach has been demonstrated that uses a low flow rate, low-pressure drop cooling scheme, and demonstrates low jitter and low thermal distortion at absorbed heat fluxes near 100 W/cm(sup 2).

REPORT NUMBER: LA-SUB-93-300
ACCESSION NUMBER: DE-94-008095

Adamski, John L. and D.A.G. Deacon. “FEL (Free Electron Laser) Optics Coating Test Program (Design Phase of Sample Introduction Chamber).” Final Report. Seattle, WA: Boeing Aerospace Co., February 1986. 76p. Prepared in cooperation with Deacon Research, Palo Alto, CA.

Abstract: The performance of the free electron laser for the directed energy weapons application depends critically on only three technologies: the high brightness accelerator, the FEL amplifier, and the cavity optics. Our goal in this program is to examine the performance of the optical elements under the combined loading of the fundamental and the harmonic emissions of the FEL amplifier. The performance of both the RF linac based FEL and the induction linac based FEL may be subject to significant limitations due to UV-induced absorption in the early optical elements following the FEL amplifier. These limitations are expected to appear suddenly at a certain fluence level, with little warning. Our central objective in this program is to measure the rate of the UV induced absorption, and to identify the scaling parameters so that we can predict with some confidence the performance limitations of the optics. When these limits are reached in the experimental programs, a knowledge of the scaling relations and possible countermeasures will be invaluable in planning an appropriate response to the problem.

ACCESSION NUMBER: AD-A169 474

“Advanced Weapons Technology Area Plan FY96.” Kirtland AFB, NM: Phillips Laboratory, January 1996. 31p.

Abstract: The FY 96 Advanced Weapons Technology Area Plan describes Phillips Laboratory's exploratory and advanced technology development in laser technology, beam control, imaging, RF weapons, and space control assessments. Each of these thrusts is described in terms of its user needs, goals, major accomplishments, changes from last year, and milestones.

PL-TM-96-1002
ACCESSION NUMBER: AD-A303 766 [also available via DTIC's Fulltext Technical Reports Internet Site]

"Aerial T1 EMP (Electromagnetic Pulse) Effects Assessment." Volume 1. Final report. Bethesda, MD: Booz-Allen and Hamilton, Inc., 15 May 1987. 69p.

Abstract: The Office of the Manager, National Communications System (OMNCS) has undertaken the Electromagnetic Pulse (EMP) Mitigation program to support the survivability objectives addressed by National Security Decision Directive 97 (NSDD-97) and Executive Order 12472. The objective of this program is to mitigate the damaging effects of nuclear weapons on regional and national telecommunications capabilities. To meet this objective, the OMNCS has sponsored efforts to create a network-level model to assess the effects of high-altitude EMP (HEMP). In addition, the OMNCS has sponsored various efforts to collect the system-level HEMP effects data required to support the network-level model. The products of this model assist the NCS in identifying potential vulnerabilities of national telecommunications capabilities to HEMP and supporting National Security and Emergency Preparedness (NSEP) initiatives. This report presents an assessment of the survivability of aerial T1 systems in a HEMP environment. This effort includes a test program to collect the data required to assess coupling of incident electromagnetic fields to aerial T1 cables. Also this report documents the test activities and the data collected. It also reviews the results of the buried T1 system assessment and summarizes the relevant data. Based on these data, conclusions are drawn concerning the survivability of typical aerial T1 cable systems. Finally, recommendations are presented for addressing remaining issues relevant to this assessment.

ACCESSION NUMBER: AD-A195 905

"Aerospace 2020." Volume 2 – Main Report. Neuilly-Sur-Seine, France: Advisory Group for Aerospace Research and Development, September 1997. 190p. See also **AD-A331 359**.

Abstract: Volume II, the main volume, of the report of the NATO Advisory Group for Aerospace Research and Development (AGARD) study: Aerospace 2020'. This study explored the most advanced technologies, relevant to aerospace, being researched and developed in laboratories today. The study focused on the most promising current technologies and the organisational and tactical consequences they will have at the field and system levels, over the course of the next 25 years. Topics include: a discussion of the impact of proliferation, human-machine interaction, synthetic environments, directed-energy weapons, information technologies, unmanned tactical aircraft, suborbital launchers, hypersonic missiles, and a discussion of affordability issues. Technologies are assessed from the viewpoints of both potential capabilities and threats. Observations and recommendations are presented. Volume III contains technical papers in support of the conclusions reached. Volume I is a short summary of the conclusions.

REPORT NUMBER: AGARD-AR-360-VOL-2
ACCESSION NUMBER: AD-A331 358

"Aerospace 2020." Volume 3 – Background Papers. Neuilly-Sur-Seine, France: Advisory Group for Aerospace Research and Development, September 1997. 142p. See also **AD-A331 358**.

Abstract: Volume III, the technical papers supporting the report of the NATO advisory Group for Aerospace Research and Development (AGARD) study: Aerospace 2020'. This study explored the most advanced technologies, relevant to aerospace, being researched and developed in laboratories today. The study focused on the most promising current technologies and the

organisational and tactical consequences they will have at the field and system levels, over the course of the next 25 years. Topics include: a discussion of the impact of proliferation, human-machine interaction, synthetic environments, directed-energy weapons, information technologies, unmanned tactical aircraft, suborbital launchers, hypersonic missiles, and a discussion of affordability issues. Technologies are assessed from the viewpoints of both potential capabilities and threats. Observations and recommendations are presented. Volume II contains the conclusions of the report. Volume I is a short summary of these conclusions.

REPORT NUMBER: AGARD-AR-360-VOL-3
ACCESSION NUMBER: AD-A331 359

Agenbroad, Jerald R. "Applicability of Lasers to Close Air Support for the United States Marine Corps." Maxwell AFB, AL: Air War College, April 1988. 48p.

Abstract: A brief discussion of the rationale for having an aviation branch in the USMC precedes a more detailed background on the concerns and objectives of Close air support (CAS). This leads to the requirement for increasing the accuracy of the weapons in the CAS arsenal; hence, the exploration of laser designators, laser receivers, and laser guided weapons for employment in the conduct of CAS. The Marine philosophy for fire support coordination and the doctrinal prerequisites for the conduct of effective CAS are examined to assess the degree to which they have been impacted by the introduction of lasers. A description of the laser equipment in the Marine inventory is presented with an analysis of some operational considerations which derive from the characteristics of that equipment and laser energy in general. Following that background, two potential applications for lasers in CAS are analyzed: the use of laser technology for the terminal guidance of weapons, and the use of laser equipment as an augmentation to the communication process necessary for the conduct of CAS. The author presents his recommendations for using lasers in CAS and suggests a course for the USMC to follow in the future.

ACCESSION NUMBER: AD-A202 645

Albridge, Royal G. et al. "Surface Reactions in the Space Environment." Final report. 1 November 1989-30 April 1991. Nashville, TN: Vanderbilt Univ., Center for Atomic and Molecular Physics at Surfaces. May 1992. 12p.

Abstracts: The object of this research program is to carry out experimental and theoretical studies of the detailed microscopic mechanisms by which electronic energy is absorbed, transported and dissipated in ionic solids. The ultimate aim of this program is identify and characterize essential constituent elements of comprehensive models which will quantitatively describe radiation-induced electronic phenomena. The theoretical and experimental aspects of the project have been carried out concurrently and interactively in order to realize the greatest scientific benefit from the collaboration. Throughout this project we have employed (1) experimental techniques already developed to monitor bulk and surface properties before, during, and after electron and photon irradiation and to characterize time and energy-dependent desorption phenomena, and (2) ab initio quantum-theoretical approaches to develop and refine computational models for determining properties of excited electronic states of relevant localized species. This research program bears directly on a broad spectrum of questions germane to the long-term operation of platforms in space, including structural, optical and electronic degradation of materials in the ambient near-earth environment, survivability under and hardening against irradiation from directed-energy weapons, vulnerability in disturbed nuclear atmospheres, and discrimination and sensing techniques based on radiation (glow) signatures.

REPORT NUMBER: AFOSR-TR-92-0424
ACCESSION NUMBER: AD-A250 624

Alvarez, R.A. “High-Power Pulse Propagation Experiments.” Livermore, CA: Lawrence Livermore National Laboratory, 2 December 1986. 6p. In: General Meeting of the American Physical Society, New York, NY, USA, 16 March 1987.

Abstract: One of the questions that must be answered in assessing the potential of pulsed microwave beams as directed energy weapons is, "What is the maximum pulse energy (and/or peak power) that can be delivered from a source to a target." Atmospheric breakdown caused by the electromagnetic fields of the pulse sets one limit on energy propagation, and the breakdown threshold was the subject of fairly extensive investigation a number of years ago. The evolution of microwave source technology has extended the parameter range over which propagation needs to be understood, and additional issues that have not previously been investigated experimentally have assumed a new importance. A new generation of experiments is underway, planned, or proposed to investigate these issues.

REPORT NUMBER: UCRL-95-773, CONF-870308-1
ACCESSION NUMBER: DE-87-003441

Anselmo, Estelle R. “VAASEL-ANSYS Comparison for a Thermally Loaded Beam.” Wright-Patterson AFB, OH: Wright Laboratory, August 1991. 16p.

Abstract: This report presents the results of calculating the deflection and stresses in a thermally loaded beam. Three different methods were used for the calculation: classical beam theory, ANSYS (Version 4.4) and VAASEL (Version 1.1). Comparisons between each of the methods are presented.

REPORT NUMBER: WL-TM-92-308-FIBE
ACCESSION NUMBER: AD-A251 003

Antinone, R. and W.C. Ng. “HPM (High Power Microwave) Testing of Electronic Components.” Livermore, CA: Lawrence Livermore National Laboratory, 10 May 1989. 79p.

Abstract: This report documents the results of a study of high power microwave (HPM) vulnerability of electronic components commonly used in weapon systems. The study was carried out at the Lawrence Livermore National Laboratory from August through October 1988. The objective of this study was to determine the threshold levels for upset or disturbance and damage of the devices under test (DUT). In these tests pulsed microwave energy was directly injected into the terminal of the DUT and in most cases a 50-ohm microstrip test fixture was used to ensure that 50-ohm transmission was maintained as close to the DUT as possible.

REPORT NUMBER: UCID-21687
ACCESSION NUMBER: DE-89-016682

Argo, P.E. “HF Propagation Through Actively Modified Ionospheres.” Los Alamos National Laboratory, NM, 1990. 9p. In: Ionospheric Effects Symposium, Washington, DC (USA), 1-3 May 1990. p. 542-549. [**AD-A233 797**]

Abstract: We have developed a computer modeling capability to predict the effect of localized electron density perturbations created by chemical releases or high-power radio frequency heating upon oblique, one-hop hf propagation paths. We have included 3-d deterministic descriptions of the depleted or enhanced ionization, including formation, evolution, and drift. We have developed a homing ray trace code to calculate the path of energy propagation through the modified ionosphere in order to predict multipath effects. We also consider the effect of random index of refraction variations using a formalism to calculate the mutual coherence functions for spatial and frequency separations based upon a path integral solution of the parabolic wave equation for a single refracted path through an ionosphere which contains random electron density fluctuations.

REPORT NUMBER: LA-UR-90-906, CONF-9005150-1

ACCESSION NUMBER: DE-90-008931

Arun, R.S. et al. “Systolic Algorithms for Imaging From Space.” Final Report. 1 August 1986 – 31 July 1989. Savoy, IL: Illinois University at Urbana, Coordinated Science Laboratory, 31 July 1989. 28p.

Abstract: The goal of the Strategic Defense Initiative is to develop technologies that can be used to defend against the threat of nuclear ballistic missiles. Primary components of a strategic defense system would be a high resolution sensing or imaging system for surveillance, acquisition, tracking, and overall monitoring of targets, and a weapons system possible utilizing directed energy or kinetic energy technologies for destroying targets. The research in this project was aimed at developing algorithms and CLSI architectures for high resolution imaging from space. The problems studied were from two major, related categories: algorithm definition and development, and VLSI implementation of signal and image processing algorithms. In the first category, the imaging problems studied were from synthetic aperture radar, high of the work was to find high-performance algorithms suitable for high-speed implementation on multi processor arrays. The second aspect of our work focussed on VLSI implementation of signal processors, the analysis of finite register length effects, and the development of short wordlength, low noise structures for signal and image processing.

ACCESSION NUMBER: AD-A213 870

Ayres, V.M. “Nonlinear Analysis of Non-Neutral Plasmas.” Report for 1 October 1986-30 September 1987. Silver Spring, MD: Naval Surface Warfare Center, 30 September 1987. 35p.

Abstract: The purpose of this investigation is to incorporate nonlinear effects into the analysis of non-neutral plasma beams in order to accurately estimate their performance in realistic situations. Intense non-neutral plasma beams have important applications for DEW, SDI, high power microwave/millimeter wave production and particle beam guidance systems.

ACCESSION NUMBER: AD-A192 506

Barnard, J.J. “High Spatial Frequency Thermal Blooming Instability: A Linear Stability Analysis.” Livermore, CA: Lawrence Livermore National Laboratory, April 29, 1988. 24p. Presented at the Workshop on Physics of Directed Energy Propagation in the Atmosphere, Las Cruces, NM, 29 March 1988.

Abstract: The fine-scale thermal blooming instability is shown to be affected by the laser pulse length. In this study, we calculate the asymptotic gain of a sinusoidal perturbation as a function of pulse length and perturbation wave number. We include the effects of viscosity, diffusion, and wind shear, and we heuristically estimate the effects of turbulence. We find that for short laser pulses, the small wave perturbations are reduced due to acoustic effects. However, large wave number perturbations remain large and extend to a higher cutoff in wave number than in the long laser pulse limit. At wave numbers higher than this cutoff, thermal diffusion causes exponential decay of the perturbations. For long laser pulse length wind shear and turbulence limit perturbation growth.

REPORT NUMBER: UCRL-98068, CONF-8803106-1
ACCESSION NUMBER: DE-88-010711

Barr, T.A., Jr. and W.B. McKnight. “Plasmas as Light Sources for Lasers.” Huntsville, AL: Alabama, September 1984. 47p.

Abstract: This report describes an experimental and analytical investigation of the properties of high intensity, visible wavelength, light sources for optical pumping of pulsed lasers. Background information on research that may be applicable to this problem is presented, the experiment design is outlined and the results of system modeling are detailed. The experimental apparatus,

consisting of a Blumlein pulse-forming network and a cylindrical plasma cell load, is described. The instrumentation use for the experiment is discussed, and experimental results are presented, together with a possible explanation of the optical radiation-time history of the plasma. Potential applications are evaluated and future development recommended.

ACCESSION NUMBER: AD-A159 460

Baucom, Donald R. “Origins of the Strategic Defense Initiative: Ballistic Missile Defense, 1944-1983.” Final report. Washington, DC: Strategic Defense Initiative Organization, December 1989. 406p.

Abstract: America's ballistic missile defense program may be said to have its roots in the V-2 attacks on London in 1944. This document traces the development of antiballistic missile defense policy from the V-2 attacks up to President Reagan's 1983 speech announcing the new strategic defense initiative. The history follows the policy debates from the NIKE-X, SALT I and SALT II, the ABM Treaty, and SAFEGUARD through research and development innovations in the areas of computers, optical sensors, interceptors, and directed energy weapons. The emergence of political organizations and individuals who either opposed or championed ballistic missile defense is also included.

ACCESSION NUMBER: AD-A242 465

Bayer, G.C. “Training Implications of Directed Energy Weapons for the U.S. Army: A Preliminary Report” Final report. September 1983-September 1984. Fort Walton Beach, FL: Litton Systems, Inc., Mellonics Systems Development Division, October 1986. 109p.

Abstract: This report addresses the need to fill information gaps in training and doctrine on directed energy. A comprehensive presentation of nonclassified descriptions of directed energy types, employment possibilities, and appropriate countermeasures serves as the major portion of this report. Directed energy proliferation on the battlefield is a critical issue faced by commanders and soldiers alike. The results of a pilot test suggest that relatively simple training that can minimize directed energy weapon effectiveness on individual and crew performance can be developed and presented to soldiers. A closing issue is discussion of directed energy to generate widespread understanding of directed energy effects and capabilities and the need to reconsider the classification level of some information. A large body of directed energy information is currently held as sensitive when in fact it could be made available to concerned field commanders and trainers in general format. Specified classified details could easily remain sensitive while the release of common knowledge would permit trainers to develop comprehensive responses to the directed energy threat.

REPORT NUMBER: ARI-RR-1431
ACCESSION NUMBER: AD-A179 827

“BEAR Electrostatic Analyzer: Flight Results.” Los Alamos National Laboratory, NM. 3 January 1990. 8p. In: Spacecraft Charging Technology Conference, Monterey, CA, 31 October - 3 November 1989.

Abstract: The Electrostatic Analyzer (ESA) measured the intensity of charged particles returning to the BEAR payload during flight on 13 July 1989. These particles form part or all of the current that returns to the payload to neutralize the charge ejected with the beam. By measuring the return flux with high time resolution, we can study the physics of charging processes. When the neutralizer was off, the payload emitted 10 mA negative and charged to several hundred volts with a maximum of(approximately)800V. With the neutralizer on (normal configuration) the payload emitted (approximately) 1mA negative and received electrons with energies up to a few hundred volts in some attitudes. This suggests charging to a few hundred volts. The charging rate of the payload is consistent with the rocket body capacitance with respect to a vacuum.

REPORT NUMBER: LA-UR-90-296, CONF-89-103581
ACCESSION NUMBER: DE-90-006511

Benford, J. and J. Swegle. “Applications of High Power Microwaves.” San Leandro, CA: Physics International Co., 1992. In: Intense Microwave and Particle Beams III, Los Angeles, CA, 20-24 January 1992. Proceedings of the SPIE - The International Society for Optical Engineering, vol.1629, p. 69-80.

Abstract: There is a strong symbiotic relationship between a developing technology and its applications. New technologies can generate applications previously either unrealizable or impractical. Conversely, applications can demand the development of new technological capability. Examples of both types of development can be found in the evolution of high power microwaves (HPM). The high power and energy output made possible by HPM have created a technology driven interest in directed energy weapons and short pulse radar. On the other hand, the requirements for heating of fusion plasmas have resulted in an application driven program to develop high average power microwave devices. In this paper, the authors address these and other applications such as RF electron linacs, laser pumping, and beaming of power. Emerging applications, such as ionospheric modification and environmental cleanup, are also touched upon. Each application is reviewed separately and the requirements of the applications are compared in terms of the power, frequency and other key requirements necessary for HPM to usefully address the application.

Bengston, Joel, et al. “Emerging Technologies Program Integration Report. Volume 1. Narrative, Analyses and Assessment.” Final report. McLean, VA: Science Applications International Corp., 4 May 1987. 144p.

Abstract: The objective of the Emerging Technologies Program is to identify key technology areas of high interest to the DoD, for investment purposes. The two volumes of the integration report assess and synthesize information gathered through a Delphi survey, defense needs prioritization workshops, and assessments of high priority areas. Volume I of the report contains the actual narrative, analysis, and assessments that have been developed; in Volume II are the background, Delphi and workshop data from which the analysis and assessments were drawn. The specific technologies considered are: command, control, and communications; directed energy; manufacturing; biotechnology; human factors; mobility, search and surveillance; and electronic warfare.

ACCESSION NUMBER: AD-A196 733

Benham, R.A . “New LIHE (Light Initiated High Explosive) Test Capability for Spherical Targets.” Albuquerque, NM: Sandia National Labs., 1987. 2p. In: Annual SDI Technical Achievements Symposium, Washington, DC, 1 March 1987.

Abstract: A goal of the Defense Nuclear Agency Lethality and Target Hardening (LTH-3) Program is to assess the lethality of the x-ray laser against the SDI threat entourage of boosters, post-boost vehicles (PBVs), reentry vehicles, and defense suppression weapons (DSWs). A principal characteristic of the effects of the x-ray laser on such threats is the delivery of a cosine distributed impulsive load to exposed curved surfaces of the targets. The LTH-3 program is using test and analysis techniques to investigate the structural response of models of typical targets and target components subjected to impulsive flood loads. A new capability for testing spherical targets using Light Initiated High Explosive (LIHE) is the subject of this paper. Spherical targets are of interest to LTH-3 since vulnerable pressurant, propellant, and chemical reactant storage vessels in PBVs and DSWs are likely to be generally spherical in design.

REPORT NUMBER: SAND-86-2366C, CONF-870398-1/SUM
ACCESSION NUMBER: DE-87-003035

Bennett, W.H. et al. “Nonlinear Dynamics and Control of Flexible Structures.” Annual report. September 1987-August 1988. Greenbelt, MD: Systems Engineering, Inc., 15 November 1988. 159p.

Abstract: The unprecedented requirements for rapid retargeting and precision pointing for spaced-based directed energy weapon platforms is the prime driver behind the reported modeling and control study. The combination of such requirements demand a comprehensive dynamic model of the nonlinear multibody dynamics of typical space platforms for such weapon including the interaction platform structural flexure effecting principal weapon system effective Line-Of-Sight. This report describes the first year effort of a three year project which focuses on: (1) the development of comprehensive; generic nonlinear dynamical models for typical space-based plat forms, (2) the development of high performance, nonlinear control laws for rapid slewing and precision pointing of primary weapon system payload apertures, and (3) the design of a series of laboratory experiments to verify and test the control laws developed. The validation of the analytical models and the required control theory for the resulting class of nonlinear system is described in this report. Simulation results are given for a simplified benchmark model of a space-based laser slewing control and consideration for compensation for structural flexure effecting optical LOS using optical steering mirrors is discussed.

REPORT NUMBER: AFOSR-TR-90-0201
ACCESSION NUMBER: AD-A218 372

Bennett, W.H. et al. “Nonlinear Dynamics and Control of Flexible Structures.” Annual report. September 1988-August 1989. Greenbelt, MD: Techno-Sciences Inc., 12 December 1989. 128p

Abstract: Basic performance requirements for space-based directed energy weapons involve unprecedented requirements for integrated control of rapid retargeting and precision pointing of space structures. Multibody interactions excite nonlinear couplings which complicate the dynamic response. Attempts to reduce flexure response for such weapon platforms by passive techniques alone may be inadequate due to stringent pointing requirements. The principal objective of the research program is the validation and testing of high precision, nonlinear control of multibody systems with significant structural flexure where interactions arise due to rapid slewing. Dominant nonlinear couplings effecting LOS response have been identified based on a comprehensive model of the nonlinear multibody dynamics of a generic space weapon. The innovative approach to LOS slewing/pointing developed in this study is based on implementation of decoupling (by feedback control) of the principal nonlinear dynamics and structural flexure response. In this study we have focused on the implementation of partial feedback linearization and decoupling and have identified practical conditions for its implementation. A principal contribution of the study is the reconciliation of design of discontinuous control via sliding mode control with partial feedback linearization for rapid slewing of system effective LOS. The report includes extensive simulation and tradeoff studies of nonlinear control implementation of rapid slewing and precision pointing of a generic model of a space-based laser beam expander.

REPORT NUMBER: AFOSR-TR-90-0200
ACCESSION NUMBER: AD-A218 476

Bennett, H. et al. “Nonlinear Dynamics and Control of Flexible Structures.” Final report. 1 September 1987-31 August 1990. Greenbelt, MD: Techno-Sciences, Inc., 10 October 1990. 142p.

Abstract: Basic system requirements for space-based directed energy weapons will require unprecedented levels of control system performance to achieve slewing maneuvers for rapid retargeting and precision alignment of structural components supporting optical system components. Rapid, multiaxis slewing maneuvers will excite multibody dynamics involving nonlinear interactions with structural flexure. Advanced methods of modeling multibody systems

with structural flexure are described and several issues in modeling slewing and pointing maneuvers for multibody systems are discussed based on Lagrange's method. Advanced methods in nonlinear control system design based on dynamic inversion by feedback linearization are then applied to a generic model of a Space Based Laser system. Connections with methods of sliding mode control are described along with practical aspects of implementation. Reduced order modeling issues and implementation of feedback linearizing control for robust stabilization are described. Experiments are outlined for validation and demonstration of critical aspects of nonlinear control for rapid, large angle slewing and precision pointing.

REPORT NUMBER: AFOSR-TR-91-0051
ACCESSION NUMBER: AD-A232 795

Binhong, Li and Songcun Peng. "Theory and Simulent Design of a Type of Auto-Self-Protecting Optical Switches." Translation of **Shanghai Jiaotong Daxue Xuebao (China)** 1984, n. 6, p. 11-23. Wright-Patterson AFB, OH: Wright Laboratory, 11 June 1990. 21p.

Abstract: As the use of lasers in the military and in the civilian economy increases with each passing day, it is often necessary for the human eye or sensitive instruments to observe weak lasers, such as the return waves of laser radar and laser communications signals; but it is also necessary to provide protection against damage to the eye from the strong lasers of enemy laser weapons. For this reason, it is necessary to have a kind of automatic optical self-protecting switch. Based upon a study of the transmitting and scattering characteristics of multilayer dielectric optical wave guides, a practical computer program is set up for designing a type of auto-self-protecting optical switch with a computer model by using the nonlinear property of dielectric layers and the plasma behavior of metal substrates. This technique can be used to protect the human eye and sensitive detectors from damage caused by strong laser beams.

REPORT NUMBER: FTD-ID (RS) R-0306-90
ACCESSION NUMBER: AD-A225 344

Bittel, R.H. et al. "RF and Laser Space-Based Communications Links: Another Perspective." In High Data Rate Atmospheric and Space Communications; Proceedings of the Meeting, Boston, MA, September 8-9, 1988. Bellingham, WA: Society of Photo-Optical Instrumentation Engineers, 1988, p. 20-27.

Abstract: The advanced technology required to achieve high data rate satellite-to satellite communications is presently being investigated. A comparison of RF with direct detection laser communications (lasercom) for application to high data rate Strategic Defense System (SDS) low and medium earth orbit crosslinks is presented. This comparison is based on near term technology suitable for early deployment in the SDS. The RF system is a millimeter-wave system operating in the 60 GHz region; the lasercom system is considered to operate in the near infrared, from 0.8 to 1.1 microns. The trades consider operation in benign as well as the very stressing environments postulated for the SDS which include low and high altitude nuclear bursts as well as the threat of space-based jamming sources and directed energy weapons. Results of the trade are presented to show the advantages and disadvantages of each type of system.

Blackfield, D.T. "NOISE: A Nonlinear Optimization Induction Free-Electron Laser Systems Engineering Code." Livermore, CA: Lawrence Livermore National Laboratory, August 1989. 36p.

Abstract: We have developed a computer code to assist in the design of a ground-based induction free-electron laser (FEL) proposed for construction at the White Sands Missile Range. Called NOISE (for Nonlinear Optimization Induction Free-Electron Laser Systems Engineering), the code contains algorithms for modeling and costing the eight basic IFEL assemblies (accelerator, amplifier, master oscillator, optical conditioning, controls and data acquisition,

ancillary and alignment systems, prime power, and technical facilities). A set of nonlinear equations is used to optimize a figure of merit (FOM) subject to various engineering constraints. The FOM is typically total cost (less facilities costs) but may be any combination of variables used by NOISE. The NOISE architecture is highly modular so that assembly routines can be easily modified. Trade studies can be quickly performed over a wide range of dimensions (up to 34 variables with up to 12 constraints). In addition, NOISE contains a "spreadsheet" or benchmark mode that calculates feasible, but not necessarily optimized, design points. We review various nonlinear optimization techniques, show how the techniques influenced NOISE development, and describe in detail the code's subroutines and capabilities.

REPORT NUMBER: UCID-21543
ACCESSION NUMBER: DE-90-004438

Bloomberg, H.W. "Importance of Secondary Electron Collisional Ionization (Avalanche) for X-Ray Pulses Incident on Missiles-in-Flight." Technical report. 1 February 1984-14 May 1985. Reston, VA: Beers Associates, Inc., 14 May 1985. 53p.

Abstract: This report present a series of contour plots for both strong and moderate avalanche on the electric field-pressure plane. Plots are given for effective electric field durations from 0.1 to 100 ns, consistent with times corresponding to X-ray pulse widths of interest in nuclear weapon effects. The computations were carried out with special concern for accuracy. The adequacy of the air chemistry data set is confirmed by comparison with experimental swarm data. The effect of the delay for the avalanche frequency to reach its steady state value is included in the calculations.

ACCESSION NUMBER: AD-A168 112

Bogan, W.R. "Comparison of EMP (Electromagnetic Pulse) and HERO (Hazardous Electromagnetic Effects on Ordnance) Programs." Master's thesis. Monterey, CA: Naval Postgraduate School, December 1988. 150p.

Abstract: Because of the unique features of electromagnetic pulse (EMP) and Hazardous Electromagnetic Effects on Ordnance (HERO), much research and money has gone into protecting weapon systems and ordnance against it. The EMP and HERO phenomena do have a variety of differences and require differences of hardening technique to protect against it. However, they both involve radiation effects and can prematurely initiate ordnance via the electroexplosive device (EED). Protection of weapon systems and ordnance against electronic damage and upset plus EED initiation takes on more of an art form rather than science once basic principles are applied. Nevertheless by relating these two programs via the initiating temperature of the EED, they can be accurately compared with each other. Because of this observation, the two programs can be effectively combined to work jointly on ordnance hardening and protection including all forms of radiation type hazards, present and future.

ACCESSION NUMBER: AD-A203 924

Borg, E.J. et al. "AMC-SWMO Countermeasures Study. Volume 1. Guide to How Countermeasures Affect Smart Weapons." Final technical report. 29 September 1991-15 June 1992. Huntsville, AL: Dynetics, Inc., January 1992. 99p.

Abstract: This volume provides background technical and programmatic information on the complex subject of how smart weapons (SW) are affected by countermeasures (CM) on the battlefield. It defines CMs as devices, techniques, or actions that respond to a specific weapon or capability. The volume covers threat CMs and how US Army SW can be made more robust in a CM environment. It focuses on the technical details of threat CM classes. These are designated: signature alteration, decoys and deception; obscurants, and jammers and directed energy weapons (DEW). In additions to technical discussions on the CM classes, it also includes the process by which the Army incorporates CM effects into the design, analysis, requirements, definition and testing of SW. It gives the current roles and responsibilities of various government agencies involved in the CM assessment process. Guidelines and suggestions are presented and discussed to assist the smart weapon system program manager (PM) in ensuring that more CM

robust smart weapons are developed. Although the PM is the primary focus of this volume, everyone involved in the SW and CM planning process should benefit from the information provided.

REPORT NUMBER: AMSMICR-SW-92-01
ACCESSION NUMBER: AD-A263 833

Borg, E.J. et al. “AMC-SWMO Countermeasures Study. Volume 1. Guide to How Countermeasures Affect Smart Weapons.” Special report for period ending 19 June 1989. Chicago, IL: Tactical Weapon Guidance and Control Information and Analysis Center, June 1993. 110p.

Abstract: This volume provides background technical and programmatic information on the complex subject of how smart weapon sensors are affected by countermeasures (CMs) on the battlefield. This report defines CMs as devices, techniques, or actions that respond to a specific weapon action or capability. The subject of this volume will be threat CMs and how US Army smart weapons can be made to be more robust in a CM environment. The focus is on the technical details of threat CM classes. These classes are designated as: signature alteration, decoys, and deception, obscurants, and jammers and directed-energy weapons (DEWs). In addition to a technical discussion of CM classes, the process by which the Army incorporates CM effects into the design, analysis, requirements definition, and testing of smart weapons will also be discussed. The roles and responsibilities of various Government agencies involved in the CM assessment process are presented as it currently exists. Guidelines and suggestions are presented and discussed to assist the smart weapon system program manager (PM) in ensuring that more CM robust smart weapons are developed. Although the PM is the primary focus of this volume, everyone involved in the smart weapon and CM planning process should benefit from the information provided.

REPORT NUMBER: GACIAC-SR-93-01/VOL 1
ACCESSION NUMBER: AD-A271 628

Borror, Sean L. “Star Calibration of the Pallet Inertial Sensor Assembly for the High-Altitude Balloon Experiment.” Kirkland AFB, NM: Phillips Laboratory, 1995. In: The International Society for Optical Engineering Acquisition, Tracking, and Pointing IX, 1995, Orlando, FL, April 19-20, 1995. Bellingham, WA: SPIE – the International Society of Optical Engineering (SPIE Proceedings, vol. 2468), 1995, p.219-230.

Abstract: A gyroscope star calibration algorithm developed for use in the High-Altitude Balloon Experiment, a program to resolve acquisition, tracking, and pointing/fire control issues in support of future directed energy programs, is presented. The initial acquisition of a target from a free-floating balloon platform necessitates an inertial pointing capability. Gyroscopes are normally used to measure angular rotations with respect to an inertial reference frame. Given an initial attitude, the gyro measurements can be used to determine the altitude at any later time. For the High Altitude Balloon Experiment, GPS and a magnetometer are used to provide an initial estimate of the payload attitude. This paper describes a deterministic algorithm, which uses star sensors measurements to correct initial attitude uncertainty errors. In addition, a simple method for measuring gyro bias in flight is presented. The consequences of star sensor to gyro frame misalignment are examined for both rate gyros and angular pulse output gyros. This paper describes the algorithm used to meet the calibration accuracy required to inertial pointing of the gimbaled payload.

Boyer, K. “Directed Energy Beam Weapons.” In: Electro-Culture ’84; Proceedings of the Meeting, Arlington, VA, May 1-2, 1984. Bellingham, WA: SPIE – the

International Society of Optical Engineering (SPIE Proceedings, vol. 474), 1984, p.79-86.

Abstract: A development status assessment is made for neutral particle beam and free electron laser directed energy beam weapons, from the viewpoint of the stringent performance requirements imposed by the concept of 'layered defense' in orbit against nuclear missile attack. Attention is given to the design features and operating principles of these devices; it is noted that free electron lasers for different wavelength regimes employ different electron accelerator technologies that will have to be individually developed. It is also noted that the RF 'racetrack' free electron laser accelerator configuration furnishes high efficiencies at short wavelengths.

Boyer, William B. "Flexible Automated Waveform Recorder Data-Acquisition Program." p. 188-196. In **IEEE Transactions on Instrumentation and Measurement Instrumentation and Measurement Technology Conference**. v. IM-33, 3 September 1984 Long Beach, CA. Sponsored by: IEEE, Society of Instrumentation & Measurements, New York, NY, USA.

Abstract: None available.

Brigge, Richard J. "Induction Linacs and Free Electron Laser Amplifiers." Berkeley, CA: University of California, Livermore Radiation Laboratory, March 20, 1986. 56p.

Abstract: The purpose of this conference, as I understand it, is to bring together the communities involved in fusion research with those involved in directed energy weapons research. Steve Dean pointed out in his opening remarks that there have actually been many connections in the past between activities in fusion research and directed energy weapons. The purpose of the Astron experiment was to generate plasma confinement through magnetic field reversal from a circulating electron ring. Next to the Astron fusion experiment was a buncher ring in which the electron beam from the Astron accelerator went around in a circle and over into a 60-foot propagation tank next door. The purpose of the buncher ring was to make a chopped electron beam to study beam propagation in air. This was a program called Seesaw, funded by DARPA. It started in the late 1950's, and the original purpose of that research program was to look at ballistic missile defense concepts with particle beams. Incidentally, the building that housed this experimental apparatus is currently the site of the large magnetic mirror experiment, MFTF. These investigations of field reversed plasma confinement states for magnetic fusion, the basis for Nick Christofilos' Astron concept, and the particle beam weapon research, both involved making new kinds of accelerators for very high beam currents, unprecedented in their day. The idea that was born out of this need was the linear induction accelerator.

REPORT NUMBER: UCRL-94312
ACCESSION NUMBER: AD-A339 022

Brown, P.S. "Requirements for the Development of Advanced Nuclear Weapon Concepts." Livermore, CA: Lawrence Livermore National Laboratory, 15 January 1990. 17p. In: Workshop on New Nuclear Weapon Concepts and Their Implications for International Security and Arms Control, Darmstadt (Germany, F.R.), 17-20 January 1990.

Abstract: In this paper, requirements for the development of advanced nuclear weapon concepts are discussed. This paper addresses third generation nuclear weapons, and the advance workshop literature describes third generation nuclear weapons as including earth penetrating warheads (EPWs) and maneuvering reentry vehicles (MARVs), as well as nuclear directed energy weapons (NDEWs). A historical context for the evolution of advanced nuclear weapon concepts is presented, discussing the types of advanced concepts and how they differ from conventional nuclear weapons currently in the stockpile. The policy context for doing R&D

on nuclear directed energy weapons and how this R&D relates to the Strategic Defense Initiative (SDI) is discussed. Some military requirements for the various advanced concepts and discuss potential missions are provided, indicating the potential advantages and disadvantages of the various applications. Arms control and stability considerations as they relate to the development of advanced concepts and the implications of the rapidly changing political relationships between the US and the Soviets, and between their respective allies are also discussed.

REPORT NUMBER: UCRL-JC-103507, CONF-900197-1
ACCESSION NUMBER: DE-90-012465

Browning, J.S. "Single Event Upset from Neutral Particle Beams." Albuquerque, NM: Sandia National Labs., 1989. 23p. In: SUBWOG-6P Joint US/UK Working Group, Livermore, CA, USA, 26-28 June 1989.

Abstract: Are single event upsets an important vulnerability or lethality issue for strategic systems. Neutron-induced single events have become a part of the vulnerability analysis for nuclear weapon environments, but there has been no serious consideration of proton-induced single events from neutron particle beam environments. Is this appropriate This paper examines this concept.

REPORT NUMBER: SAND-89-1749C, CONF-8906202-1
ACCESSION NUMBER: DE-89-015323

Burzynski, Richard and Martin K. Casstevens. "Chemical Processing of Novel Multifunctional Materials for Sensors Protection Against Laser Threats." Final Report. 15 September 1990 – 15 May 1991. Amherst, NY: Laser Photonics Technology, Inc., 14 May 1991. 28p.

Abstract: There is an immediate need for the development of materials that could function to protect human vision and light sensitive equipment from laser based weapons. The goal of the just concluded research was to synthesize a compound that would incorporate a nonlinear two photon absorbing functional group adjacent to a photoreactive moiety, This innovative approach would lead to broad band high optical transparency at lower power levels and efficient and fast attenuation at higher power levels. The use of organic compounds in this application ensures that the molecular structure could be further optimized by careful adjustment of the molecular structure. The synthesized compound, anthracene leuconitrile, was found to be photochemically unstable and took and inappropriately long time for the reconversion from the absorbing to the transmitting form.

REPORT NUMBER: AFOSR-TR-91-0587
ACCESSION NUMBER: AD-A237 716

Cabayan, H.S. "Current Status of High Power Microwave Effects and Simulation." Livermore, CA: Lawrence Livermore National Laboratory, December 1986. 9p. In: National Conference on High Power Microwave Technology for Defense Applications, Albuquerque, NM. 1 December 1986.

Abstract: This article is based in part on the findings of the HPM Effects Panel. The findings of the panel have been reported elsewhere, and are summarized here. Issues that are covered include potential upper bounds of the influences from HPM weapons, the phenomenology of HPM system effects, critical issues in HPM system effects simulation, and HPM simulation requirements.

REPORT NUMBER: UCRL-95-052, CONF-8612401-8
ACCESSION NUMBER: DE-87-004112

Cabayan, H.S. "Phenomenology of Intense Electromagnetic Wave Interactions with Systems."

Livermore, CA: Lawrence Livermore National Laboratory, 12 March 1986. 9p. In: Electromagnetic Compatibility Society Institute for Electrical and Electronics Engineers, San Jose, CA, 29 April 1986.

Abstract: Recent advances in laboratory high power microwave (HPM) source capabilities have raised concerns regarding the survivability of US systems if HPM weapon systems using such sources are deployed in the battlefield. In this paper an overview of recent US achievements in HPM sources is given. Upper bounds to future HPM threats on targets from first principles are derived. Again using a simplified first principles approach, the phenomenology of HPM interaction with targets is examined and scaling laws for the target response with frequency, pulse width, and influence are derived.

REPORT NUMBER: UCRL-94-285, CONF-8604341-1, CONF-8606317-1
ACCESSION NUMBER: DE-87-009561

Camacho, J.F., E.T. Rosenbury and B.R. Poole. "X-band Backward-wave Oscillator Experiment." Livermore, CA: Lawrence Livermore National Laboratory, 1990. 6p. In: National Conference on High-Power Microwave Technology (5th), West Point, NY (USA), 10-15 June 1990.

Abstract: We are conducting a backward-wave oscillator (BWO) experiment using a slow-wave structure which consists of a non-sinusoidal corrugated-wall waveguide with period z(sub 0) = 1.67 cm, r(sub min) = 1.17 cm, r(sub max) = 1.97 cm, and length L = 15.03 cm (nine periods). We inject an annular electron beam with the following parameters: (Phi)(sub cathode) = 1 MV, 1 kA (le) I(sub beam) (le) 7 kA in 1 kA increments, r(sub beam) = 0.9 cm, and t(sub pulse) (approx.) 60 ns. The guiding axial magnetic field is varied from 0.6 T to 3.0 T in 0.4 T increments. The device is designed to operate at 8.0 GHz < f < 8.5 GHz in the lowest-order TM mode of the coupled beam-structure system. We shall present our experimental design and results. In addition, our theoretical and modeling work will be discussed.

REPORT NUMBER: UCRL-102625, CONF-9006179-5
ACCESSION NUMBER: DE-90-015119

Canavan, Gregory H. "Advanced Defense Technologies in Transition." Los Alamos National Laboratory, NM. October 1988. 30p.

Abstract: This report discusses the sensitivities of current defensive technologies to the threat, how advanced kinetic energy and directed energy weapons (KEWs and DEWs) could reduce them, and their scaling and optimal combinations. The result is a demonstration that an orderly progression from KEWs to DEWs obtains for nominal costs, performance, and threats.

REPORT NUMBER: LA-11361-MS
ACCESSION NUMBER: DE-89-002105

Canavan, Gregory H. "Advanced Mass Launchers for Low Earth Orbit." Los Alamos National Laboratory, NM. April 1989. 43p.

Abstract: Military access to space requires significant payload volume and acceptable costs. It has not been demonstrated that current launch systems can provide either. This report describes two advanced launch concepts that could potentially provide an order of magnitude reduction in the total costs of launching modest payloads to space and give the margin over the economics of current concepts required to meet both current and expanded requirements for military and civilian launch schedules and provide a margin for the expansion of each.

REPORT NUMBER: LA-11420-MS
ACCESSION NUMBER: DE-89-010759

Canavan, Gregory H. “Approximate Average Deployments Versus Defense Parameters.” Los Alamos National Laboratory, NM. December 1991. 7p.

Abstract: Calculations of the number of reentry vehicles (RVs) killed as a function of missile and defense parameters can be well approximated by analytic expressions that are valid for all numbers of missiles and interceptors. The approximation uniformly underestimates the effectiveness of boost-phase defenses: the discrepancies in kill rates are about 10%. If it is used to size the boost phase of two-layer defenses, the uncertainties would at worst double the demands on the midcourse layer, which is generally a minor part of the total.

REPORT NUMBER: LA-11880-MS
ACCESSION NUMBER: DE-92-004751

Canavan, Gregory H. “Average Deployments Versus Missile and Defender Parameters.” Los Alamos National Laboratory, NM. March 1991. 15p.

Abstract: This report evaluates the average number of reentry vehicles (RVs) that could be deployed successfully as a function of missile burn time, RV deployment times, and the number of space-based interceptors (SBIs) in defensive constellations. Leakage estimates of boost-phase kinetic-energy defenses as functions of launch parameters and defensive constellation size agree with integral predictions of near-exact calculations for constellation sizing. The calculations discussed here test more detailed aspects of the interaction. They indicate that SBIs can efficiently remove about 50% of the RVs from a heavy missile attack. The next 30% can removed with two-fold less effectiveness. The next 10% could double constellation sizes.

REPORT NUMBER: LA-11856-MS
ACCESSION NUMBER: DE-92-003989

Canavan, Gregory H. “Burros: Simple, Affordable, Effective Space Transportation.” Los Alamos National Laboratory, NM. May 1992. 23p.

Abstract: This note argues that space is the best place to put not only the sensors, but also the SBIs Spare Based Interceptors and DEWs Directed-Energy Weapons needed to address long-range, intra- and inter-theater missiles efficiently. There are real threats; they are likely to worsen. Ground-based defenses cannot handle them all affordably. Mixes are generally appropriate. There is a role for SBIs, but it doesn't appear to require all of the capabilities built into the current SBIs at the outset. The SBIs that are needed now could be no more than cheap burros that were amenable to joint development and robust command for the protection of all. Their deployment for (GPALs) Global Protection Against Limited Strikes should not adversely impact the arms control or crisis stability of the strategic balance with the Soviet Union in any rational, concrete calculus, including that used by the Soviet Union. Deployment at low latitudes should give them adequate capability against theater launches but none against Soviet (ICBMs) International Ballistic Missiles and only marginal, residual impact on (SLBMs) Submarine-Launched Ballistics Missiles. They should not either leave hot production capability of anything threatening or provoke untoward responses. We have a hot production line on Chevrolets that would pose more of a threat to the Soviet Union. Their inability to overcome even crude Soviet countermeasures would be an asset in this light. A companion effort could develop the brilliant eyes needed to guide them. A similar logic is possible with DEWs, but they are less developed and hence less at issue.

REPORT NUMBER: LA-12197-MS
ACCESSION NUMBER: DE-92-013553/AD-A338 702

Canavan, Gregory H. “Comparison of Laser and Neutral Particle Beam Discrimination.” Los Alamos National Laboratory, NM. September 1989. 16p.

Abstract: The relative ability of lasers and neutral particle beams (NPBs) to discriminate reentry vehicle (RV) and anti-satellite (ASAT) decoys is pivotal in assessing their relative worth as strategic defenses. This report evaluates their ability and assesses their relative contributions,

concluding that NPBs can typically discriminate about 100 times as many objects as can lasers, and do so with significantly greater certainty.
REPORT NUMBER: LA-11572-MS
ACCESSION NUMBER: **DE-89-017786/AD-A 344 854**

Canavan, Gregory H. “Constellation Sizing for Modest Directed Energy Platforms.” Los Alamos National Laboratory, NM. June 1989. 11p.
Abstract: Discussions of boost-phase, directed energy scaling have concentrated on large lasers and mirrors requiring development. The report explores modest lasers that could be deployed sooner if their performance and effectiveness were found to be adequate.
REPORT NUMBER: LA-11573-MS
ACCESSION NUMBER: DE-89-012826/AD-A 339 026

Canavan, Gregory H. “Defending the Defenders: Brilliant Pebble Defense Against Pop-up Neutral Particle Beam Suppression Attacks.” Los Alamos National Laboratory, NM. May 1991. 22p.
Abstract: Pop-up neutral particle beams (NPBs) can suppress brilliant pebbles. For attrition attacks, modest shielding should suffice, although the pebbles' survivability could be degraded. NPBs are difficult to negate once operational; it appears necessary to destroy them during ascent. Doing so effectively would require the prompt destruction of all heavy launches from missile launch areas.
REPORT NUMBER: LA-11822-MS
ACCESSION NUMBER: DE-91-012521/AD-A 344 738

Canavan, Gregory H. “Directed Energy Architectures.” Los Alamos National Laboratory, NM. May 1988. 58p.
Abstract: This report discusses the roles directed energy could play in strategic defense, assesses their likely effectiveness, and outlines the important complementarity between directed and kinetic energy, which appears to be pivotal to the development of robust defenses. Directed energy concepts could provide adequate kill rates that are relatively insensitive to fast, compact launches. Midcourse applications are based on the robust discrimination ability of directed energy weapons.
REPORT NUMBER: LA-11285-MS
ACCESSION NUMBER: DE-88-010484

Canavan, Gregory H. “Directed Energy Concepts for Strategic Defense.” Los Alamos National Laboratory, NM. June 1988. 74p.
Abstract: Directed energy concepts can play unique roles in strategic defense because of their reaction time, speed of light engagement, and large geographic coverage. This report discusses the main directed energy concepts, engagements in which they could have significant leverage, and their expected performance in them. It covers both boost phase engagements and midcourse applications, and contrasts these results with those of earlier analyses.
REPORT NUMBER: LA-11173-MS
ACCESSION NUMBER: DE-88-015050/AD-A 344 716

Canavan, Gregory H. “Directed Energy Weapons-Lasers: Ground- and Space-Based Systems.”
Los Alamos National Laboratory, NM. June 1989. 35p.

Abstract: Directed energy weapons (DEWs) range and speed complement kinetic energy weapons (KEWs) lethality and offset their sensitivity to launch area and time. Lasers could be developed to the power and brightness required to offset the degradation of KEWs by advanced threats. This report reviews their scaling, discusses how they could extend the effectiveness of KEW systems, and estimates when they could enter the defenses.

REPORT NUMBER: LA-11557-MS
ACCESSION NUMBER: DE-89-012804

Canavan, Gregory H. "Goals for Limited Strategic Defenses." Los Alamos National Laboratory, NM. May 1989. 44p.

Abstract: The report reviews the nature of near and mid-term accidental, third-country, and limited threats, discusses the technologies available to defend against them, and examines the development programs required.

REPORT NUMBER: LA-11419-MS
ACCESSION NUMBER: DE-89-012260

Canavan, Gregory H. "Laser Countermeasure Impacts and Penalties." Los Alamos National Laboratory, NM. April 1988. 23p.

Abstract: Countermeasures could determine the ultimate effectiveness of directed energy weapons. This report discusses shielding and spinning boosters, the countermeasures specific to lasers, and provides an overall assessment of their impact, which is modest.

REPORT NUMBER: LA-11264-MS
ACCESSION NUMBER: DE-88-006871/AD-A 338 857

Canavan, Gregory H. "Neutral Particle Beam Popup Applications." Los Alamos National Laboratory, NM. March 1991. 28p.

Abstract: Popup neutral particle beams (NPBs) could have high leverage in discriminating decoyed threats. There is considerable leeway in the choice of platform parameters. For deuterium beams the number of platforms is modest for all energies. Hydrogen beams might use higher energies to reduce the number of platforms. Low energies minimize platform cost for both.

REPORT NUMBER: LA-11785-MS
ACCESSION NUMBER: DE-91-008160/AD-A 344 829

Canavan, Gregory H. "Notes on Space, Satellites, and Survivability." Los Alamos National Laboratory, NM. March 1991. 24p.

Abstract: The satellites most at risk in the near term are sensors and the brilliant pebbles for boost-phase defense. The availability of countermeasures for kinetic energy anti-satellites (ASATs) tends to downgrade them. Space-based interceptors and lasers are even less effective. Space mines appear to be the dominant space-based threat. Their main advantages are simplicity and low mass. If they can be forced to use decoys or cannot discriminate, that advantage is lost. For fundamental reasons discrimination should become more robust in time and combined defenses should become more effective.

REPORT NUMBER: LA-11847-MS
ACCESSION NUMBER: DE-91-009229/AD-A 344 782

Canavan, Gregory H. "Requirements for Progressive Strategic Defenses." Los Alamos National Laboratory, NM. March 1991. 52p.

Abstract: Space-based layers face counter-measures, cost, and survivability concerns. Midcourse defenses face decoys, which they must discriminate. Simple models indicate that their initial deployment should be effective and that development could improve their effectiveness. That would provide a hedge against uncertainty and an incentive to the reduction of offensive forces.

REPORT NUMBER: LA-11781-MS
ACCESSION NUMBER: DE-91-008997/AD-A 344 725

Canavan, Gregory H. "Role of Free-Electron Lasers in Strategic Defense." Los Alamos National Laboratory, NM. March 1990. 17p.

Abstract: Directed-energy defenses could provide the performance, growth, and cost essential for effectiveness against progressively larger and more competent threats. Because they are less sensitive to modernization rates and can grow in performance, directed-energy defense could provide significant margin against uncertain costs and improve the effectiveness of combined defenses by factors of 2 to 3. Delays in development could cause much larger cost growths. Thus, directed-energy, generally, and free-electron lasers, specifically, are critical in bounding the threat throughout the transition.

REPORT NUMBER: LA-11774-MS
ACCESSION NUMBER: DE-90-008028

Canavan, Gregory H. "Scaling of Nonnuclear Kinetic-Energy Antisatellites." Los Alamos National Laboratory, NM. May 1990. 22p.

Abstract: Nonnuclear antisatellites could release particles in the paths of satellites. The antisatellite would have about a twofold mass advantage in attrition and about a tenfold advantage in suppression over the defensive satellite. Antisatellites would weigh 5--10 tons; satellite shields could weigh a factor of 2-4 less. Exchange ratios scale strongly on antisatellite mass, maneuver, and range. Such antisatellites would be less effective against directed energy satellites, which could clear their paths or destroy the anti-satellites before deployment.

REPORT NUMBER: LA-11716-MS
ACCESSION NUMBER: DE-90-009758

Canavan, Gregory H. "SDI (Strategic Defense Initiative): Is Its Future Past." Los Alamos National Laboratory, NM. March 1990. 23p.

Abstract: This paper reviews likely threats and the ability of known defenses to address them, concluding that initial deployments should be affordable and development appears to be a prudent hedge against an uncertain future. Effective defenses would provide a positive incentive for the reduction of offensive forces and hence a direct, stabilizing influence that could shift the threat in directions in which they could be more effective and mutually useful.

REPORT NUMBER: LA-11782-MS
ACCESSION NUMBER: DE-90-008016

Canavan, Gregory H. "SDI (Strategic Defense Initiative): Myth or Reality." Los Alamos National Laboratory, NM. June 1988. 20p.

Abstract: This report reviews previous attempts to develop strategic defenses, the technologies currently under consideration by the Strategic Defense Initiative (SDI), their main unknowns, and the likely performance of strategic defense concepts against evolving threats.

REPORT NUMBER: LA-11322-MS
ACCESSION NUMBER: DE-88-015059

Canavan, Gregory H. “Strategic Defense Requirements for Progressive Applications.” Los Alamos National Laboratory, NM. March 1991. 36p.

Abstract: A companion paper discusses various applications for which strategic defense concepts could be used. The applications form a progression in size and complexity from accidental or unauthorized launches, through third country or subnational threats, to limited or strategic exchanges. This report attempts to quantify the requirements for meeting those applications ad to assess the maturity of current strategic defense concepts relative to them, concluding that there are adequate interceptors for all of them, but that sensitivities to uncertainties in discrimination are awkward at all levels and bothersome at the high end. Strategic defenses are applicable to a progression of threats that range from accidental or unauthorized launches, through third country of subnational threats, to limited or strategic exchanges. Technologies exist for long range launches, but launches close to shore are feasible, stressing, and favor the attacker. Space based interceptors are suited to meeting the bulk of the launches; directed energy has significant advantages in reducing the threat to manageable levels. Current interceptor concepts appear adequate, but discrimination is both pivotal and delayed.

REPORT NUMBER: LA-11830-MS
ACCESSION NUMBER: DE-91-009045/AD-A 344 761

Canavan, Gregory H. “Suppression of Space-Based Interceptors by Neutral Particle Beams.” Los Alamos National Laboratory, NM. November 1991. 15p.

Abstract: Neutral particle beams (NPBs) popped up before missile launch could irradiate space-based interceptors (SBIs), suppressing those that could effectively attack the missiles. NPB effectiveness could be quite high against unshielded, undecoyed SBIs. The results sensitive to launch radius, beam brightness, and SBI hardness. Even low-brightness NPBs would be effective in suppressing the threats over compact launch areas.

REPORT NUMBER: LA-11855-MS
ACCESSION NUMBER: DE-92-004339/AD-A 344 986

Canavan, Gregory H. “Survivability of Large Directed-Energy Platforms.” Los Alamos National Laboratory, NM. October 1991. 10p.

Abstract: There are adequate discussions in the literature of the survivability of space platforms that are small. Discussions of the survivability of large space platforms are less developed. In part that is because the large directed-energy platforms are thought to be useful in the long term; in part it is because of a rough concept that they are vulnerable simply because they are large. Size does matter for passive survivability techniques such as hardening, maneuver, and decoys. Both initial- and life-cycle mass and cost trades strongly favor lasers that are attacked. Their advantage is shielding, which is independent of platform size. The analysis of NPBs is more complex, but again reduces to the greater ease of shielding. Thus, in the most stressing attacks size plays no role. These results are generic. They show the advantage of shielding for any attacked platform.

REPORT NUMBER: LA-12078-MS
ACCESSION NUMBER: DE-92-002603

Canavan, Gregory H. “Target Returns for Neutral-Particle-Beam Discrimination.” Los Alamos National Laboratory, NM. May 1990. 18p.

Abstract: Models of weapons and decoys adequate for deposition studies can be formulated and solved analytically. Empirical conversion efficiencies predict useful weapon signals and weapon-to-decoy signal ratios for those energies of interest. Light decoys are of concern because of the numbers possible. Discriminating them on the basis of mass appears feasible with hydrogen or deuterium beams, contrary to earlier studies of much heavier decoys.

REPORT NUMBER: LA-11752-MS

ACCESSION NUMBER: DE-90-009759/AD-A344 698

Canavan, Gregory H. “Transitional Strategic Defense Architectures.” Los Alamos National Laboratory, NM. March 1989. 24p.

Abstract: Transitional deployments permit the rational evolution of increasing capability in each defensive layer. Boost-phase and midcourse transitions are discussed; a key feature is the need for balance between deployment and development.

REPORT NUMBER: LA-11524-MS
ACCESSION NUMBER: DE-89-008312

Canavan, Gregory H. and A.G. Petschek. “Satellite Allocation for Boost-Phase Missile Intercepts.” Los Alamos National Laboratory, NM. April 1987. 32p.

Abstract: An essential component of the debate over strategic defense is the size of the defensive constellations needed to counter given threats. Although computer simulations can give accurate estimates, analytic calculations can led to greater insight and sensitivity. Limiting estimates have been published in which missiles are assumed to be launched from either an enormous area or a point; neither assumption corresponds to current threats. The combined solution derived here obtains the optimal solution for all areas. The resulting constellations are both smaller and less sensitive to parameters than those derived for the two published limits.

REPORT NUMBER: LA-10926-MS
ACCESSION NUMBER: DE-87-007719

Canavan, Gregory H. and J.C. Browne. “Directed Energy Concepts for Theater Defense.” Los Alamos National Laboratory, NM. October 1991. 11p.

Abstract: This report explores the role of directed energy weapons (DEWs) in theater defenses. For ranges shorter than 200--300 km they are much cheaper than SBIs; they are competitive with ground-based interceptors (GBIs). For inter-theater ranges of (approx.) 1000 km, lasers are competitive with the SBIs, but NPBs are significantly cheaper than either. For nominal laser and space-based interceptor (SBI) costs, lasers are strongly preferred for ranges under 300--500 km. For ranges 700 km, SBIs have a slight advantage. Neutral particle beams (NPBs) appear dominant for ranges over 400--1000 km.

REPORT NUMBER: LA-12094-MS
ACCESSION NUMBER: DE92002604

Canavan, Gregory H. and J.C. Browne. “Free Electron Lasers in Strategic Defense.” Los Alamos National Laboratory, NM. March 1988. 29p.

Abstract: This report discusses the basis for free electron laser (FEL) operation, roles FELS could play in strategic defense, expected effectiveness, and status of key components. The constellation sizes needed to meet evolving threats are derived, and the tradeoffs between space and ground basing of FELs are discussed, leading to a conclusion that FELs could be available for, and play complementary roles to, those of kinetic energy concepts.

REPORT NUMBER: LA-11225-MS
ACCESSION NUMBER: DE-88-007024/AD-A 340 634

Canavan, Gregory H. and J.C. Browne. “Neutral Particle Beam Discrimination and Lethality.” Los Alamos National Laboratory, NM. March 1991. 22p.

Abstract: Using, or possibly just developing, neutral particle beams (NPBs) to both discriminate decoys and kill weapons could induce 10-fold reductions in each. The conventional "factor of two" increase in the time required to do both does not capture particle beams' impact. They could

reduce the threat to (approx.)1 reentry vehicle (RV) plus (approx.)10 decoys per heavy missile, which could be defeated at a 10-100:1 cost effectiveness ratio by current interceptors.
REPORT NUMBER: LA-11773-MS
ACCESSION NUMBER: DE-91-009009

Canavan, Gregory H. and J.C. Browne. “Roles for Neutral Particle Beams in Strategic Defense.” Los Alamos National Laboratory, NM. April 1988. 122p.
Abstract: Neutral particle beams can play a number of unique, critical roles in strategic defense because of their robust mechanism for discrimination and kill. Their operation, status, and applications are evaluated, showing that their near term roles are complementary to kinetic energy weapons. In addition, particle beams are shown to be the primary candidates for interrogating space objects, discriminating numerous light decoys possible in midcourse, and eliminating reentry vehicles among them.
REPORT NUMBER: LA-11226-MS
ACCESSION NUMBER: DE-88-010476

Canavan, Gregory H. and J.C. Browne. “Where Directed Energy Stands in Strategic Defense.” Los Alamos National Laboratory, NM. January 1988. 28p.
Abstract: Directed energy concepts can play unique, significant roles in strategic defense. This report reviews the various stages in their prior development, assesses their current status, and indicates the key indicators of offensive system development that determine the time frame in which they will be needed. Directed energy concepts are significantly less sensitive to kinetic energy countermeasures, for which they could be ready.
REPORT NUMBER: LA-11172-MS
ACCESSION NUMBER: DE-88-005092

Canavan, Gregory H. and J.H. Hammond. “Constellation Sizing for Modest Directed Energy Platforms.” Los Alamos National Laboratory, NM. April 1988. 24p.
Abstract: Discussions of boost phase directed energy constellation scaling have concentrated on tradeoffs for large lasers and mirrors, which require development. This report explores more modest lasers that could be deployed sooner, finding that for anticipated threats, performance and effectiveness are adequate.
REPORT NUMBER: LA-11238-MS
ACCESSION NUMBER: DE-88-007033/AD-A339 026

Capen, George S. “Directed Energy Effects on the Flight Path of a Spinning Ballistic Projectile.” Monterey, CA: Naval Postgraduate School, June 1995. 95p.
Abstract: This thesis will examine the equations of motion for a spinning ballistic projectile. The goal of such an examination is to determine the possible mechanisms by which a directed energy weapon may induce sufficient instability as to significantly alter the projectile's flight path. A ballistic projectile is generally launched with a fire and forget philosophy. The desired impact point is determined before firing. It may be possible to alter the projectile in such a way that it fails to follow the desired trajectory thereby missing the intended target. Several variables appear to be worthy of investigation to assess their contribution to a required instability or range reduction. Skin friction drag may be increased from surface roughness generated by a pulsed energy source. The results that this thesis will examine include: impulse generated by the laser interaction, additional Magnus effects and aerodynamic drag. Moment induced instability may also result from these in the form of a Magnus moment or drag torque. Increasing the drag force appears to be the most promising theoretical solution to defeating an incoming spinning ballistic projectile.

ACCESSION NUMBER: AD-A303 096

Carter, Ashton B. "Directed Energy Missile Defense in Space." Background paper. Washington, DC: Office of Technology Assessment, April 1984. 93p.

Abstract: This Background Paper describes and assesses current concepts for directed-energy ballistic missile defense in space. Its purpose is to provide members of Congress, their staffs, and the public with a readable introduction to the so-called 'Star Wars' technologies that some suggest might form the basis of a future nationwide defense against Soviet nuclear ballistic missiles. Since these technologies are a relatively new focus for U.S. missile defense efforts,little information about them has been readily available outside the expert community. Directed-energy or 'beam' weapons comprise chemical lasers, excimer and free electron lasers, nuclear bomb-powered x-ray lasers, neutral and charged particle beams, kinetic energy weapons, and microwave weapons. In addition to describing these devices, this Background Paper assesses he prospects for fashioning from such weapons robust and reliable wartime defense system resistant to Soviet countermeasures. The assessment distinguishes the prospects for perfect or ear-perfect protection of U.S. cities and population from the prospects that technology will achieve a modest, less-than-perfect level of performance that will nonetheless be seen by some experts as having strategic value. Though the focus is technical, the Paper also discusses, but does not assess in detail, the strategic and arms control implications of a major U.S. move to develop and deploy ballistic missile defense (BMD).

REPORT NUMBER: OTA-BP-ISC-26
ACCESSION NUMBER: PB84-210111
ACCESSION NUMBER: AD-A337 830

Casey, K.F. “Notes for a Tutorial on DEW Signal Generation, Propagation, and Detection.” Del Mar, CA: JAYCOR, October 1987. 122p.

Abstract: These notes were prepared to support a two-day tutorial lecture series which was presented at Headquarters, Air Force Foreign Technology Division in October 1987. The intent of the lectures was to provide an introduction to, and overview of, three subject areas relevant to the electromagnetic aspects of the Directed Energy Intelligence (DEWINT) problem. These areas are (1) signal generation by charged-particle beams (CPB) and high-power microwaves (HPM), (2) propagation of electromagnetic signals through the ionosphere, and (3) performance of correlation receivers for signal detection. The level of the material was intended to be suitable for an audience whose technical background was at the BS or MS level in electrical engineering or physics.

REPORT NUMBER: UCRL/CR-110115
ACCESSION NUMBER: DE-92-011847

Cauble, R. et al. “Short Pulselength lasers and Weapons Physics Applications.” Livermore, CA: Lawrence Livermore Laboratory, March 1, 1992. 17p.

Abstract: Ultrashort pulselength lasers (or short pulse lasers) offer the possibility to experimentally investigate regimes of physics which have hitherto been only calculationally accessible. Pulselengths of less than a picosecond focused into spots of a few micron radius allow millijoule amplifiers to produce field intensities of 1018 W/sq cm, an electric field corresponding to the atomic field strength for hydrogen (e/a(sub o)(sup 2) = 10(sup 9) V/cm). In addition, since the techniques for creating short pulselengths can be assembled on an optical table, research into the physics of intense electric fields can be carried out relatively cheaply at the university level. Since the field is very new and many applications of short pulse lasers are largely unexplored or not yet conceived, the Laboratory should be an active participant in the physics and applications of short pulse lasers under the Laboratory’s directive to conduct research into and on the frontiers of science. Because we are on the frontier, however, applications are likely to be limited for the next few years. Some applications are outlined in this paper.

REPORT NUMBER: UCRL-ID-109834

ACCESSION NUMBER: DE-92-016745

"Challenge of Future EW System Design (Les Defis Poses par la Conception des Futurs Systemes)." Conference proceedings. Advisory Group for Aerospace Research and Development, Neuilly-sur-Seine (France). 21 October 1993. 148p. Papers Presented at the Avionics Panel Symposium at Ankara, Turkey on 18-21 October 1993. Theme in English and French.

Abstract: Electronic Warfare (EW) has emerged as a critical driving force in modem warfare. New generations of weapon systems directly impact EW requirements and strategies. Modern combat aircraft are faced with a drastic change of a possible threat scenario consisting of a mix of Western and Eastern weapon systems. The deployment of advanced pulse doppler radar systems in A/A and GIA application augmented by extensive electro-optic capabilities, directed energy weapons (laser or particle beam), electromagnetic/shockwave weapons requires a detailed reassessment of NATO EW processes. The complexity and diversity of future threat scenarios necessitate changes in NATO EW system concepts, and an update of existing equipment including modifications of tactics and combinations of EW resources to improve survivability.

REPORT NUMBER: AGARD-CP-546
ACCESSION NUMBER: AD-A297 519

Chang, C.I. "Design and Analysis of Aerospace Structures at Elevated Temperatures." In: International SAMPE Symposium and Exhibition, 34th, Reno, NV, May 8-11, 1989. Proceedings, Book 1. Covina, CA: Society for the Advancement of Material and Process Engineering, 1989, p. 656-666.

Abstract: An account is given of approaches that have emerged as useful in the incorporation of thermal loading considerations into advanced composite materials-based aerospace structural design practices. Sources of structural heating encompass not only propulsion system heat and aerodynamic surface heating at supersonic speeds, but the growing possibility of intense thermal fluxes from directed-energy weapons. The composite materials in question range from intrinsically nonheat-resistant polymer matrix systems to metal-matrix composites, and increasingly to such ceramic-matrix composites as carbon/carbon, which are explicitly intended for elevated temperature operation.

Chen, H. C. and H.S. Uhm. " Diocotron Instability of an Intense Relativistic Electron Beam in an Accelerator." Silver Springs, MD: Naval Surface Weapons Center, White Oak Laboratory, 1 August 1984. 26p.

Abstract: High current annular electron beam in an accelerator is subject to various instabilities. A general fluid-Maxwell theory of the diocotron instability is developed for an infinitely long and azimuthally symmetric annular electron beam propagating along an external magnetic field. In contrast with the treatment used in the conventional diocotron instability, the assumptions of tenuous electron beam and strong magnetic field have been eliminated. Furthermore, the restriction of infinite axial wavelength perturbation has been removed and the approximation of % ck is no longer applied. Instead, we conduct full electromagnetic perturbation in the macroscopic cold fluid description of plasma dynamic with the beam parameters of general interest. In the special case of a sharp boundary density profile, the diocotron instability which dominates in the low frequency. region are investigated in a broad range of beam parameters and geometries. The results are significantly different from that obtained from the conventional diocotron instability. The kink mode can be destablizied and the growth rates are much larger for every azimuthal mode.

REPORT NUMBER: NSWC/MP-84-346
ACCESSION NUMBER: AD-A339 841

Chen, K.W. "Magnetic Linear Accelerator (MAGLAC) as Driver for Impact Fusion (IF)." In DOE Impact Fusion Workshop, Los Alamos, NM, 10-13 July 1979. East Lansing, MI: Michigan State University, Cyclotron Laboratory, July 1979. 24p.

Abstract: *This paper presents considerations on the design of a magnetic linear accelerator suitable as driver for impact fusion. We argue that the proposed approach offers an attractive option to accelerate macroscopic matter to centiluminal velocity suitable to fusion applications. Design and practical engineering considerations are treated. Future work are outlined.*

REPORT NUMBER: MSU-CSL-71
ACCESSION NUMBER: AD-A339 845

Chesser, N.J. "Department of Defense Methodology Guidelines for High Power Microwave (HPM) Susceptibility Assessments." Draft. Washington, DC: Office of the Secretary of Defense, January 1990. 100p.

Abstract: It is the intention of the National HPM Program to complete a series of tests over the next two years to validate the methodology described in these guidelines. When those tests are completed and results analyzed, this document will be revised to reflect lessons learned during the validation process. In addition, the Methodology Sub-Panel is compiling a second volume on specific measurement techniques. This volume (Volume 1) is intended to provide guidance to the Program Manager on the critical steps in a well-conceived test program. Volume 2 will provide detailed step-by-step information to the engineer who is responsible for performing the tests. The body of this volume is divided into seven sections. Sections 2 through 7 provide detailed descriptions of the activities within each of the modular steps which comprise the methodology schematically; Section 2: pre-test system analysis; Section 3: low power microwave tests -- coupling/subsystem component tests; Section 5: susceptibility assessment and test planning; Section 6: high power microwave tests; and Section 7: susceptibility assessment and test evaluation. The executive summary reviews the reasons for development of the methodology and provides brief descriptions of each module. Appendix B provides definitions of special terms and acronyms which are used throughout the document.

REPORT NUMBER: UCRL-CR-104314
ACCESSION NUMBER: DE-90-015405

Christensen, C.P. "High-pressure Continuously Tunable CO2 Laser." Alexandria, VA: Potomac Photonics, September 1984. 18p.

Abstract: Operation of carbon dioxide waveguide lasers at laser gas pressures of several atmospheres can significantly increase peak output power and optical pulse energy and allow continuous wavelength tunability over a broad spectral band. In the investigation, the feasibility of CO2 waveguide laser operation at elevated pressures is demonstrated. An advanced waveguide laser excited by a high-power radio frequency generator and employing novel discharge concepts is constructed and experimentally characterized. Significant increases in laser pulse energy and peak output power are observed, and factors influencing laser efficiency and range of operating pressure are explored. As a result of its improved operating characteristics this advanced waveguide laser is expected to find applications in laser radar, remote sensing, laboratory instrumentation, and materials processing.

ACCESSION NUMBER: PB-87-103727

Christophorou, L.G. and S.R. Hunter. "Binary and Ternary Gas Mixtures with Temperature Enhanced Diffuse Glow Discharge Characteristics for Use in Closing Switches." Patent Application. Oak Ridge National Laboratory, TN. Filed 28 June 1988. 26p.

Abstract: An improvement to the gas mixture used in diffuse glow discharge closing switches is disclosed which includes binary and ternary gas mixtures which are formulated to exhibit decreasing electron attachment with increasing temperature. This increases the efficiency of the conductance of the glow discharge and further inhibits the formation of an arc.

ACCESSION NUMBER: DE-89-011807

Clark, Darwin L. “Theory for the CEBAF Infrared and Shipboard FELS.” Monterey, CA: Naval Postgraduate School, March 1992. 80p.

Abstract: The continuing development of the free electron laser (FEL) as a powerful and versatile source of coherent radiation steadily drives toward the goal of high efficiency and broad tunability at shorter wavelengths. New experiments provide significant data and insight for analysis by theoreticians and experimentalists. Two important areas of study are short electron pulse effects, and the dynamics of optical mode distortion by intense beam currents. The initial part of this thesis examines one aspect of the projected task of FEL application as a military weapon. The advantages of the FEL over other directed energy sources are detailed, as well as the challenge presented by the effects of the marine atmosphere to high energy laser propagation. The remainder of this thesis examines several effects of long wavelength FELs. Chapter IV examines the proposed parameters of the CE-OAF IR FEL, and the analysis leads to predictions describing system performance. Chapter V examines the effects of single pass optical mode distortion for FELs with narrow electron beams. Single-mode theory states that gain is proportional to the product of electron beam current and filling factor, but three dimensional simulations show that gain is a function of electron beam-filling factor alone. Also examined is a phenomenon of destructive interference of light in the FEL modulator.

ACCESSION NUMBER: AD-A252 174

Cohen, Leslie, Robert Collins and Bohdan Balko. “A Report on the Possible Benefits of Using High-Temperature Superconductor Materials in Particle Accelerator Design.” Final report. June-September 1987. Alexandria, VA: Institute for Defense Analyses, December 1988. 25p.

Abstract: This report discusses different design concepts for particle beam accelerators. It demonstrates that with the use of high temperature superconducting materials, a more compact, lighter, and more robust accelerator design can be realized for the space based neutral particle beam (NPB) accelerator. Particle accelerators, Neutral particle beam, High temperature superconductivity, Cryogenic systems, Directed energy weapons, RF cavities.

REPORT NUMBER: IDA-M-444
ACCESSION NUMBER: AD-A207 174

Cohen, M, E., Fornoles, and T. Mahefkey. “Requirements and Technology Trends for Future Military Space Power Systems.” In Intersociety Energy Conversion Engineering Conference, 16th, Atlanta, GA, August 9-14, 1981, Proceedings. Volume 3. New York, NY: American Society of Mechanical Engineers, 1981, p. 2122-2125.

Abstract: Evolutionary and revolutionary changes considered necessary for satisfying increasing power requirements of military spacecraft are reviewed. Power usage is seen to expand in steps from 1-2 kW to 8 kW, 15 kW, then hundreds of kW, and finally into the MW range over the next 15 years. Applications include electrooptical and radar surveillance systems, laser communications satellites, space station defense against hostile action, transfer from LEO to GEO, and laser and directed energy weapons. The energy weapons systems would require advancements in energy storage capabilities because peak power exceeds nominal usage by 10-1000:1. Power per pound graphs are presented for nuclear and solar cell power systems, showing that nuclear systems have a 3-5:1 edge over solar systems; nuclear systems development over the next decade will, however, cost 5-10 times the amount necessary for solar development. Governing parameters will be reliability, survivability, volume, life cycle costs, availability, system weight, and risk factors. Stress is laid on the need for long lead time development to forestall revolutionary changes which require large power systems to maintain military capabilities.

Collins, C.B. “Progress in the Production of Samples of Gamma Ray Laser Candidate Materials.” Annual Technical Report 1 April 1993 – 31 March 1994. Richardson, TX: General Coherent Technology Inc., 15 April 1994. 21p.

Abstract: Studies of the 29 possible candidates to use as the working medium of a gamma ray laser have identified the 31-year isomer of Hafnium-178 as the best. It is a natural exawatt material capable of emitting 0.05 exawatt per gram if triggered. The problem being addressed in this work is the development of a production cycle for this rare substance. A success of this first year’s work has been the identification of two fuel cycles, (alpha,2n) reactions upon separated 176Yb and proton spallation upon natural Ta feedstock.

REPORT NUMBER: GCT/9401
ACCESSION NUMBER: AD-A278 961

Colson, W.B. “Collective Free Electron Laser Theory.” Final report. 30 October 1985 – 30 July 1986. Berkeley Research Associates, Inc., CA., August 1988. 51p.

Abstract: The long-pulse induction linac is considered for the first stage of a two-stage free electron laser (FEL) oscillator. This research effort studies several effects that can significantly influence the performance of such an FEL. The FEL is parameterized in a set of dimensionless variables that can summarize several physical effects without the use of detailed calculation as well as relating the physical to other FEL designs. A waveguide analysis shows the primary modifications on the FEL interaction, electron beam distribution functions representing energy spread and emittance are evaluated in the high gain regime, and a multimode analysis of the trapped-particle instability is performed for parameters describing the FEL. The research in intended to extend the simulation theory of high-gain FEL oscillators. In the two-stage FEL, the first-stage uses a normal FEL interaction with the usual static undulator to produce an intense electromagnetic wave in a high-power resonator. The wavelength in the first stage is around 1 cm, and provides the periodic undulator in the second stage of the interaction. The electromagnetic undulator has a shorter wavelength with a more intense field than can be attained from a static magnetic field, and allows the second stage to reach short optical wavelengths with a low energy electron beam.

ACCESSION NUMBER: AD-A220 750

Colson, W.B. “Free Electron Laser Theory.” Final report, no. 4. 1 May 1985 – 30 April 1986. Berkeley Research Associates, Inc., CA., 10 July 1986. 98p.

Abstract: Free electron laser (FEL) theory is extended to explain several effects associated with high gain operation. The trapped particle instability is reviewed for short pulses FELs, FEL oscillators, and FEL amplifiers. A new FEL theory exactly includes the effect of an arbitrary electron distribution function and an explanation is given for optical self-guiding.

ACCESSION NUMBER: AD-A172 996

Colson, W.B. “Methods for Tuning Free Electron Lasers to Multiple Wavelengths.” Patent. Washington, DC: Department of the Air Force, 16 June 1987. 6p.

Abstract: The tuning of the output of a free electron laser to different wavelengths is accomplished using a tilting resonator. In a free electron laser, relativistic electrons travel through a periodic magnetic field and oscillate to amplify coherent optical radiation within a resonator with same polarization as the magnet. Usually, the electron beam is parallel with the resonator axis and the fundamental harmonic is ordinarily used in the transverse magnetic field. By tilting the resonator axis with respect to the electron beam and transverse magnetic field, the free electron laser's output is tuned to different wavelengths. By using higher harmonics (f=3,5,7,...) the free

electron laser produces lasing in several wavelengths simultaneously. These several wavelengths are also tuned by the tilting resonator.

PATENT: 4,674,091

Colson, W.B. “Nonlinear Wave Propagation in Free Electron Lasers.” Final scientific report. 1 July 1985 – 31 December 1986. Berkeley Research Associates, Inc., CA., 31 December 1986. 23p.

Abstract: An outline of new research results is given in the FEL klystron theory, exotic short-pulse evolution, optical guiding in the high-gain regime, fully four-dimensional simulations of the FEL, coherence development and line- narrowing in the FEL, and a global map describing the trapped-particle instability and chaos regions in the free electron laser. The description of the high-gain klystron FEL was improved. Previous work has assumed low-gain in the analysis of the high-gain klystron design. The gain of the klystron FEL in this research was calculated with use of the coupled, self-consistent Lorentz-Maxwell equations. For high gain, the objective of the klystron configuration, the gain spectrum is found to be modified from the previously known low-gain result. This is caused by the shifting of the optical phase during the gain process and is calculated for the first time. The effects derived are not obtainable from the Madey Theorem. The klystron saturation in strong nonlinear optical fields is also discussed. A comparison is made of the use of plasma theory and distribution functions, and the single particle approach.

ACCESSION NUMBER: AD-A191 178

Colson, W.B. “Research on Free Electron Lasers.” Final report. Berkeley Research Associates, Inc., CA., 1989. 135p.

Abstract: The research includes the derivation of better high-efficiency equations for describing the FEL in the strongly saturated regime. The equations retain much of the simplicity of the old theory, but are accurate for high energy extraction. The dimensionless parameters of the equations are used to describe the LANL and LLNL FEL experiments. In a publication, the importance of the dimensionless current density j is emphasized for describing many diverse FEL physical effects. The effects of waveguides on the FEL radiation interaction are derived and presented in this report. The ELF FEL amplifier used a waveguide and is used as an example. It was found during the study that the gain spectrum of high-gain amplifiers like ELF can have sharp spikes. The spikes are not related to the use of a waveguide, but are an important result of this contract. A review paper invited by SPIE discusses some the techniques used to simulate FELs of many different kinds.

ACCESSION NUMBER: AD-A215 865

Colson, W.B., J.C. Ballardo, and P.M. Bosco. “Free-Electron Laser Gain Degradation and Electron Beam Quality.” Technical report. 1 October 1985 – 30 December 1986. Univ. of California, Santa Barbara, Quantum Institute, 17 February 1987. 18p.

Abstract: The free electron laser can be described by solving the Lorentz Maxell equations self consistently in weak optical fields. The field evolution is determined by an integral equation that allows the inclusion of an arbitrary electron distribution function in a simple way. Contour maps are used to show the gain degradation due to an electron beam energy spread and an electron beam angular spread. In the limit of low gain, the gain spectrum is related to the spontaneous emission line shape through successively higher dericatives. In the limit of high gain, it is shown that growth rate becomes less susceptible to degradation from the electron beam quality.

ACCESSION NUMBER: AD-A177 370

Colson, W.B., G. Dattoli and F. Ciocci. “Angular-Gain Spectrum of Free Electron Lasers.” Report no. 4 (Final). 1 July 1984 – 28 February 1985. Univ. of California, Santa Barbara, Quantum Institute, February 1985. 16p.

Abstract: The theory of free-electron lasers is extended to include the new coupling between an electron beam and optical wave propagating at an angle theta in an arbitrary harmonic. The coupling allows the laser to be tuned to a wider range of wavelengths and to include the effects of emittance in the electron beam. The formulation of the results in terms of coupling constants means that the existing knowledge of high gain, low gain, weak optical fields, strong optical fields, and short pulses in free electron lasers can be immediately generalized to off-axis propagation in an arbitrary harmonic.

ACCESSION NUMBER: AD-A159 412

Colson, W.B. and A.M. Sessler. “Free Electron Lasers.” Final technical report. 1 July 1984 – 28 February 1985. Univ. of California, Santa Barbara, Quantum Institute, August 1985. 58p.

Abstract: This paper reviews the experimental and theoretical development of free electron lasers. There is a review of the types of accelerators driving FELs, the history of FELs, and the prospects for the future.

ACCESSION NUMBER: AD-A159 497

Corynen, G.C. “Target Scheduling for Directed Energy Weapon Platforms.” Livermore, CA: Lawrence Livermore National Laboratory, January 1993. 180p.

Abstract: This final report documents the results of a three-year technology development program sponsored by the Rome Laboratory (RL) as part of the Strategic Defense Initiative (SDI) and executed at the Lawrence Livermore National Laboratory (LLNL). The major objectives of this program were to develop, test, and deliver algorithms for managing Directed Energy Weapons (DEW) platforms during defensive engagements with a number of offensive weapons, which we shall call the targets. The main focus of this program has been on space-based High-Energy Lasers (HEL) and Neutral Particle Beam (NPB) platforms operating in earth-orbit during the boost and midcourse phases.

REPORT NUMBER: UCRL-LR-112583
ACCESSION NUMBER: DE-93-007434

Crevier, W.F., E.D. Lakasky and W. Scharf. “Evaluation of AURORA as a Tactical Source Region Simulation.” Contractor report. Santa Barbara, CA: Mission Research Corp., February 1983. 67p.

Abstract: This memo compares the AURORA environment with that expected in an actual tactical source region environment. The primary interest in making the comparison is to evaluate the role that AURORA can play as a source region simulator for tactical systems of interest to the U.S. Army Comparisons are made between the electric and magnetic fields measured in AURORA and those computed using a four source model of AUR3D. Excellent agreement is found in the comparison between the magnetic fields. The computed electric fields show a fundamentally different behavior from those measured in AURORA.

ACCESSION NUMBER: AD-A127 139

Cullen, J.W. and D.E. Remy. “Progress on the Preparation and Characterization of Some Alkynediol Oxalate Polymers.” Final technical report. May-August 1987. Army Natick Research Development and Engineering Center, MA. 11 July 1988. 15p.

Abstract: The mechanism and effects of the interaction of high energy laser radiation with polymeric materials are of great interest to the military. One application is in the area of personnel protection from the hazards of directed energy weapons (DEW). Srinivasan and Leigh have studied the action of far-ultraviolet laser radiation on poly (ethylene terephthalate) (PET) films. Irradiation of the film caused etching to PET and formed gases such as CO, CO2, H2 and volatile organics such as benzene. The absorption of laser radiation leads to a very high concentration of free radicals in the surface layers of the PET film shortly afterward. The photoproducts (possibly in vibrationally excited states) are then ejected from the film surface and probably carry away the excess energy of the photon pulse. The result is that the photoetched film undergoes no significant temperature increase. Srinivasan and Leigh term this process an 'ablation'. Polyesters or polycarbonates should afford a greater degree of protection from a CO2 laser than other polymer types. Synthetic efforts toward more effective ablative polymers are described. Poly (1,4-but-2-ynedidyl) oxalate was prepared by transesterification of butyne -1,4-diol and diethyl oxalate. End group analysis by NMR indicated that average molecular weights were low. Several other synthetic procedures were investigated to increase the molecular weight of the polymer and are discussed. The related diacetylenic polymer poly (1,6-hexa-2,4-diyne)-diyloxalate, prepared by transesterification, could not be characterized because of the extreme thermal liability of it or a precursor.

REPORT NUMBER: NATICK/TR-88/073
ACCESSION NUMBER: AD-A212 076

Dahlbacka, Glen and John Guillory. “Laser Induced EMP (Electromagnetic Pulse) at 10.6 Microns.” Final report. January 1984-June 1986. Alameda, CA: Plasma Research Corp., May 1987. 137p.

Abstract: An extensive experimental session was analyzed (1200 shots) to investigate the behavior of Laser Induced Electromagnetic Pulse (LIEMP) parametrically CO2 laser intensity within a decade of 10 GW/sq cm 2 and with air pressure from 1 microtorr to a toor. Measured electric fields on a ground plane and current measured 3 cm from the target were compared to theory. One hundred eV suprathermal electrons (1.6 keV maximum energy) create the LIEMP after laser light, self-focussed a few fold, is resonantly absorbed. The model predicts electric field scaling as Intensity (1/2) as observed, but current scaling is not reproduced. The electric fields are no threat for CO2 and shorter wavelengths, but may pose a threat for millimeter waves. Pressure dependencies are reproduced with classical energy loss in gasses.

ACCESSION NUMBER: AD-A183 892

Dana, R.A. “Conceptual Design of a Space-Based Multimegawatt MHD Power System, Task 1 Topical Report; volume 1: Technical Discussion.” Pittsburgh, PA: Westinghouse Electric Corporation, Advanced Energy Systems Division, January 1988. 214p.

Abstract: This report presents the system requirements and design guidelines for the space based multimegawatt MHD power system conceptual design, and comprises Volume 2 of the topical report describing the Task 1 MHD Power System Conceptual Design and Development Plan. In the interest of completeness, this report includes a summary description of the MHD power system concept with the functional requirements, design scope and design objectives. Then subsequent sections present the system requirements including operational requirements, space platform/weapon system interfaces, subsystem interfaces, and design guidelines. The analytical methods used for system analysis and parametric studies are also included. A description of the MHD power system, in the standard data table format for multimegawatt space power systems, is included in the Appendices.

REPORT NUMBER: WAESD-TR-88-0002
ACCESSION NUMBER: AD-A338 996

Davis, Bill. “SDI and the Winds of Change.” White paper. Washington, DC: Strategic Defense Initiative Organization, 1993. 12p.

Abstract: An overview of the beginnings of the SDI(Strategic Defense Initiative) program during the Reagan years, the changing goals it has pursued as it progressed, and suggestions on the directions that it should take in the future.

ACCESSION NUMBER: AD-A338 822

Davis, William H. “Rail Circuit Augmentation.” Picatinny Arsenal, NJ: Army Armament Research Development and Engineering Center, Fire Support Armament Center, May 1991. 19p.

Abstract: A concept for an augmented railgun barrel and integrated projectile/armature system is presented. The system makes use of the rail geometry to expose the augmenting rails to the bore, and incorporates dual tandem armatures in the launch package. Benefits include reduced current and power required to launch a given mass and a modest reduction in sabot mass due to creation of multiple tension and compression regions resulting from the use of dual armatures. Radial and axial plasma confinement techniques may be required to take advantage to systems benefits. Application to an antiarmor mission is proposed.

REPORT NUMBER: ARFSD-TR-91-008
ACCESSION NUMBER: AD-A234 944

Deb, D et al. “Beam Switch Tube Modulator Technology for Plasma Ion Implantation Broad Industrial Applications.” In: Digest of Technical Papers. Ninth IEEE International Pulsed Power Conference. Albuquerque, NM, June 21-23, 1993. p. 333-336, vol. 1.

Abstract: Pulse power, directed energy beams and high temperature plasmas have for the past 30 years focused the requirements of their supporting technologies and the creative abilities of the community toward goals, which at least for now, seem to recede into the distant future. Yet the maturity and many successes of the supporting sciences and technologies are now poised to produce significant impact in the more traditional industrial world as well as daily life. One such example is the case of the recently invented plasma ion implantation (PII) process, which is currently under intense basic and industrial engineering investigation and development. The critical component of PII for broad industrial utilization is the modulator that applies the high voltage pulse to the workpiece. A modulator technology assessment and selection is carried out. The requirements of the PII process favor the selection of a hard-tube modulator. A hard-tube technology assessment and selection is carried out. The performance, physical operation and potential enhancements of Litton beam switch tubes L5012 and L5097 are discussed in connection with the requirements of the emerging plasma ion implantation industrial modulator technology.

“Dense Plasma Jet Propagation for Endoatmospheric Ballistic Missile Defense.” Final report. 1 October 1986-30 June 1988. Alexandria, VA: R and D Associates, Washington Research Laboratory, June 1988. 79p.

Abstract: A variety of schemes have been proposed for delivering lethal amounts of energy and/or momentum to targets such as missiles and high speed aircraft. One class of technology involves the use of high speed plasmas. The primary attraction of such technology is the possibility of utilizing relatively compact accelerators and electrical power systems that could allow highly mobile and agile operation from rocket or aircraft platforms, or in special ordnance. This research has been developing the experimental conditions necessary to achieve reasonable comparison with theoretical predictions for plasma jet propagation in the atmosphere. Time-resolved measurements have been made of high speed argon plasma jets penetrating a helium background (simulating xenon jets propagating into air). Basic radial confinement of the jet

has been observed by photography and spectroscopy and structures in the flow field resemble those predicted by numerical calculations. Results from our successful initial experiments have been used to design improved diagnostic procedures and arcjet source characteristics for further experiments.

REPORT NUMBER: AFOSR-TR-89-0720
ACCESSION NUMBER: AD-A208 655

"Description of the Proposed Action and Alternatives National Test Bed Communications Network." Santa Barbara, CA: Science Applications International Corp., July 1989. 45p.

Abstract: The President's Strategic Defense Initiative (SDI) announced on March 23, 1983, initiated an effective ballistic missile defense system. Subsequently, the Strategic Defense Initiative Organization (SDIO) was established to plan, organize, coordinate, direct, and enhance the research and testing of strategic defense technologies. Future implementation of a strategic defense system would be based, in large part, on the SDIO research program. The National Test Bed (NTB) and National Test Facility(NTF) are key elements of the SDIO's plans to conduct tests and experiments. The purpose of this document is to provide the SDIO and NTBJPO with a description of the communications system required to link the network of NTB facilities to the NTF. This DOPAA was prepared as part of the SDIO Environmental Impact Analysis Process (EIAP) described in the SDIO EIAP framework document of September 1987.

ACCESSION NUMBER: AD-A268 569

Dettmer, J.W. "Space Integrated Controls Experiment (SPICE) Program." Final report. February 1989-March 1995. Albuquerque, NM: Lockheed Missiles and Space Co. Inc., May 1995. 78p.

Abstract: The objective of the SPICE program was to demonstrate improvement in precision pointing, tracking, and retargeting by integration of active isolation, active and passive structural control, advanced materials, active optics, and adaptive control. Available finding allowed only the implementation of the active isolation and active structural control. A linear, ftill-size, and well-characterized precision test-bed was developed to represent a space-based laser beam director structure. Key SPICE subsystem developments included: (1) an optical sensing system to calculate the optical line-of-sight; (2) proof mass actuators of unprecedented stroke and force capability to deliver the control forces to the structure; (3) a finite element model that accurately modeled the 25 flexible structural modes; and (4) a robust hybrid high-authority/low-authority global control system. A series of tests culminated with the attainment of repeatable and robust attenuation of the optical line-of-sight jitter by 77:1 (six independent disturbances) and 128:1 (three independent disturbances) in the band 5 to 5OO% with little spillover into unregulated degrees of freedom. Methods by which system identification and control system design and implementation can be partially automated were investigated in the latter stages of the program.

REPORT NUMBER: PL-TR-95-1035
ACCESSION NUMBER: AD-A297 200

Dettmer, J.W. "Zenith Star Support Experiment Design." Final report. July-November 1990. Albuquerque, NM: Lockheed Missiles and Space Co. Inc., May 1995. 124p

Abstract: Experiments are proposed that can be performed on the SPICE structure in support of the Zenith Star Experiments. The fourteen experimental proposals fall into four categories: isolation of a space beam expander from on-board disturbances, evaluation of pointing and tracking systems, uses of advanced materials and passive damping, and characterization of

disturbances. At least four experiments are proposed in each category. Those rated most valuable by Zenith Star personnel include: advanced composite materials studies, admittance modeling of a passive structure, and further research into the capabilities of the Space Active Vibration Isolation System (SAVI).

REPORT NUMBER: PL-TR-94-1131
ACCESSION NUMBER: AD-A297 331

Dimiduk, David, et al. "The High Altitude Balloon Experiment Demonstration of Acquisition, Tracking and Pointing Technologies (HABE-ATP)." Kirtland AFB, NM: Phillips Laboratory, 1995. In: AGARD MSP Symposium (1st) on Guidance and Control for Future Air Defense Systems Held in Copenhagen, Denmark, 18 May 1994. 12p. [AGARD CP-555/N95-32123]

Abstract: *The High Altitude Balloon Experiment Demonstration of Acquisition, Tracking and Pointing Technologies (HABE-ATP) is a system built around balloon-borne payload which is carried to a nominal 26-km altitude. The goal is laser tracking thrusting theater and strategic missiles, and then pointing a surrogate laser weapon beam, with performance levels and a timeline traceable to operational laser weapon systems requirements. This goal leads to an experiment system design which combines hardware from many technology areas: an optical telescope and IR sensors; an advanced angular inertial reference; a flexible, multi-level of actuation digital control system; digital tracking processors which incorporate real-time image analysis and a pulsed, diode-pumped solid state tracking laser. The system components have been selected to meet the overall experiment goals of tracking unmodified boosters at 50-200 km range. The ATP system on HABE must stabilize and control a relative line of sight between the platform and the unmodified target booster to a 1 microrad accuracy. The angular pointing reference system supports both open loop and closed loop track modes; GPS provides absolute position reference. The control system which positions the line of sight for the ATP system must sequence through accepting a state vector handoff, closed-loop passive IR acquisition, passive IR intermediate fine track, active fine track, and then finally aimpoint determination and maintenance modes. Line of sight stabilization to fine accuracy levels is accomplished by actuating wide bandwidth fast steering mirrors (FSM's). These control loops off-load large-amplitude errors to the outer gimbal in order to remain within the limited angular throw of the FSM's. The SWIR acquisition and MWIR intermediate fine track sensors (both PtSi focal planes) image the signature of the rocket plume. After Hard Body Handover (HBHO), active fine tracking is conducted with a visible focal plane viewing the laser-illuminated target rocket body. The track and fire control performance must be developed to the point that an aimpoint can be selected, maintained, and then track performance scored with a low-power 'surrogate' weapon beam. Extensive instrumentation monitors not only the optical sensors and the video data, but all aspects of each of the experiment subsystems such as the control system, the experiment flight vehicle, and the tracker. Because the system is balloon-borne and recoverable, it is expected to fly many times during its development program.*

REPORT NUMBER: PL-94-LI-5

"Directed Energy Weapons Testing Raises Issues." Aberdeen Proving Ground, MD: Army Test and Evaluation Command, 20 March 1997. 4p.

Abstract: *Testing directed energy weapons (DEWs) represents a special challenge to the 21st Century tester. Continuing research and development of lasers and high-power microwave devices drives a need for the test community to create the test technology needed to evaluate these new devices. As in other types of weaponry, the tester must devise testing procedures for the two aspects (1) measuring the effects of the weapons directed against a threat target, and (2) measuring the resistive characteristics of our equipment to attack from a DEW. To appreciate the tester's challenge, let's look at the three categories of DEW's (1) lasers, (2) high-power microwave (HPM), and (3) charged particle beam (CPB) devices, and some related test issues.*

ACCESSION NUMBER: AD-A323 342

Dockery, G.D. “A Study of the Realizability and Performance of Focused-Wave Pulses.” In: Radar 92; Proceedings of the International Conference, Brighton, UK, 12-13 October 1992. London, UK: IEE, 1992. p. 126-129.

Abstract: An investigation is conducted of Ziolkowski's (1989) simulation of EM directed-energy pulse trains (EDEPTs), in the context of diffraction limits. Simulation results are compared with those obtained for a single Gaussian pulse of similar frequency content. Possible applications of EDEPTs technology encompass high-resolution radar, high energy weapons, remote sensing, and secure communications. Attention is given to array-launched EDEPTs.

Donatelli, Delia E. “Is the Weaponization of Space Inevitable?” Washington, DC: Industrial College of the Armed Forces, April 1997. 68p.

Abstract: Development of technologies for directed energy and kinetic energy space weapons systems has progressed to the point where the United States could demonstrate concepts within 5-10 years if adequate funding is provided. While Congress debates whether such weapons are needed and should be funded, the Chief of Staff of the Air Force and the Commander in Chief of United States Space Command take the position that weapons in space are necessary and inevitable. They view space as the medium where the next step in the natural evolution of military operations will occur. Operation Desert Storm emphasized the importance of space assets to US military operations, a conclusion as obvious to the rest of the world as to the US. This implies a vulnerability, noted in the recent Army After Next wargame held at the Army War College which could be exploited by any individual, nation, or state wishing to target the US. This paper addresses the need for space weapons and issues and concerns relating to their deployment. It begins with definitions of space weapon and weaponization of space. This is followed by an overview of the evolving global environment, including a summary of space activities and stakeholders. The advantages and liabilities of space weapons are discussed within the context of national interests, from military, political, and economic perspectives. Alternatives for addressing needs served by space weapons are considered.

ACCESSION NUMBER: AD-A331 513

Eckhardt, Wilfried O. et al. “Ground-Based High Power Microwave Decoy Discrimination System.” Technical Progress Report, no. 2. 1 January – 31 December 1987. Malibu, CA: Hughes Research Laboratories, 23 December 1987. 104p.

Abstract: The objectives of the subject contract are to conduct a detailed investigation of the feasibility of a ground-based high-power microwave decoy discrimination system to explore key technology items required for the implementation of such a system, and to design a prototype system. If an effective defense against a massive strategic missile attack is to become feasible, one of the important problems that must be solved is to devise a system capable of reliable discrimination between decoys and reentry vehicles. In principle, high-power microwaves (HPMs) can be expected to provide an effective discrimination mechanism. The most important features of the concept are (1) all aspects of the system, with the possible exception of long-range sensors, are ground-based, yet there is an all-weather capability; (2) HPM/target interactions can be studied in ground-based experiments; and (3) the system hardware is expected to be highly modular and thus amenable to upgrading in several stages, based on successful testing.

ACCESSION NUMBER: AD-A189 311

Edenburn, M.W. “Reference Concepts for a Space-Based Hydrogen-Oxygen Combustion, Turboalternator, Burst Power System.” Albuquerque, NM: Sandia National Labs., July 1990. 40p.

Abstract: This report describes reference concepts for a hydrogen-oxygen combustion, turboalternator power system that supplies power during battle engagement to a space-based,

ballistic missile defense platform. All of the concepts are "open"; that is, they exhaust hydrogen or a mixture of hydrogen and water vapor into space. We considered the situation where hydrogen is presumed to be free to the power system because it is also needed to cool the platform's weapon and the situation where hydrogen is not free and its mass must be added to that of the power system. We also considered the situation where water vapor is an acceptable exhaust and the situation where it is not. The combination of these two sets of situations required four different power generation systems, and this report describes each, suggests parameter values, and estimates masses for each of the four. These reference concepts are expected to serve as a "baseline" to which other types of power systems can be compared, and they are expected to help guide technology development efforts in that they suggest parameter value ranges that will lead to optimum system designs.

REPORT NUMBER: SAND-89-0423
ACCESSION NUMBER: DE-90-016692/AD-A339 004

Edeskuty, F.J. and W.F. Stewart. "Preliminary Description of the Ground Test Accelerator Cryogenic Cooling System." Los Alamos National Laboratory, NM. 1988. 15p. In: ASME Energy-Sources Technology Conference and Exhibition and 7th Intersociety Cryogenic Symposium, Houston, TX. 22 January 1989.

Abstract: *The Ground Test Accelerator (GTA) under construction at the Los Alamos National Laboratory is part of the Neutral Particle Beam Program supported by the Strategic Defense Initiative Office. The GTA is a full-sized test facility to evaluate the feasibility of using a negative ion accelerator to produce a neutral particle beam (NPB). The NPB would ultimately be used outside the earth's atmosphere as a target discriminator or as a directed energy weapon. The operation of the GTA at cryogenic temperature is advantageous for two reasons: first, the decrease of temperature caused a corresponding decrease in the rf heating of the copper in the various units of the accelerator, and second, at the lower temperature the decrease in the thermal expansion coefficient also provides greater thermal stability and consequently, better operating stability for the accelerator. This paper discusses the cryogenic cooling system needed to achieve these advantages.*

REPORT NUMBER: LA-UR-88-2498, CONF-890102-2
ACCESSION NUMBER: DE-88-016222

Eliezer, S. and I. Gilath. "Spallation and Dynamic Fracture as an Effect of Laser Induced Shock Waves in Carbon Based Composite Materials." Israel Atomic Energy Commission, Yavne Soreq Nuclear Research Center, October 1989. 47 p.

Abstract: *A high irradiance single beam short pulsed Nd:glass laser was used to generate shock waves in carbon-carbon and carbon epoxy composites. Dynamic brittle fracture at hypervelocity impact conditions was observed as a result of reflected shock waves as tensile waves from the back surface of samples. Successive stages of damage from incipient spallation to complete sample perforation were obtained by increasing gradually the laser energy. The thermo mechanical damage on the front surface as a result of laser interaction with the target material and the mechanical damage at the back surface as a result of shock wave reflection were characterized by optical and scanning electron microscopy. The failure properties of the carbon composites were related to the processing of densification and graphitization mode. While the failure properties for carbon epoxy composites were related to impact direction versus fiber direction. A comparison was made between spall properties of carbon epoxy composites with aluminum and iron. A new experimental method was developed to calculate the attenuation of laser generated shock waves. This technique enables also the evaluation of the laser induced spall pressure in different materials.*

ACCESSION NUMBER: AD-A216 540

Elizondo, Juan M. “Novel High Voltage Vacuum Surface Flashover Insulator Technology” In: Digest of Technical Papers. Ninth IEEE International Pulsed Power Conference. Albuquerque, NM, June 21-23, 1993. p. 257-260, vol. 1.

Abstract: Vacuum has been an attractive choice as insulation for high voltages due to the absence of free charge carriers. However, once a solid insulator is introduced to support the high voltage conductors the insulation ability is decreased compared to that of pure vacuum. Improvement of the insulation strength of insulators is required to increase the capabilities of pulsed power systems. Electrically stressed insulators often fail in vacuum due to dielectric breakdown. The author describes an experiment to test the HV vacuum and develop the technology, and to test the LV vacuum and to take measurements of the microstack surface charge properties.

Emergy, Mark H. “Start-Up Imprinting and Shock Dynamics in Laser-Target Interaction.” Washington, DC: Naval Research Laboratory, 10 December 1992. 27p.

Abstract: Improved uniformity of the laser for-al spot profile is a necessary criterion for the success of high intensity laser fusion and to improve the quality of data from moderate intensity laser driven shock experiments in solids. Recently developed laser smoothing techniques rely on both temporal smoothing and thermal smoothing to produce uniform ablation pressures on the target surface. Thermal smoothing is not effective during the low intensity portion of a laser pulse and the resultant shock structure mirrors the residual laser nonuniformities. The impact of the first (nonuniform) shock can be diminished by using foam layers, a precursor flash, shallow angles of incidence, and by adiabatically compressing the target with a temporally long, slowly rising laser pulse.

REPORT NUMBER: NRL/MR/6440-92-7174
ACCESSION NUMBER: AD-A261 384

Emery, Mark H. and John H. Gardner. “Shock-Free Acceleration of Laser Driven Targets.” Interim report. Washington, DC: Naval Research Laboratory, 10 December 1992. 15p.

Abstract: The ability of recently developed laser smoothing techniques to produce uniform ablation pressures is strongly contingent on the degree of thermal smoothing. Thermal smoothing is not effective at reducing residual laser nonuniformities during the start up phase of a shaped, reactor-like laser pulse. The impact of the first shock can be diminished by adiabatically compressing the target with a temporally long, slowly rising laser pulse. This memorandum report discusses an elastic-plastic laser-matter-interaction model and shows that a shock-free, induced spatial incoherence-smoothed laser pulse can accelerate a target to nearly the conditions required for uniform implosion.

REPORT NUMBER: NRL/MR/6440-92-7170
ACCESSION NUMBER: AD-A261 327

Eminhizer, Charles R. “Primer on beam Optics.” La Jolla, CA: Physical Dynamics Inc., 27 September 1993. 113p.

Abstract: This is a primer on beam optics with emphasis on neutral particle beam (NPB) optical devices. It explains how the motion of charged particles in magnetic and electric fields is calculated and how devices (primarily magnets) are designed, used and combined to make a beam transport system.

REPORT NUMBER: PD-LJ-87-350R
ACCESSION NUMBER: AD-A338 616

Engheta, N., F.C. Yang and K.S.H. Lee. "Variational Approach to Developing Relationships Among Wire Currents in a Cable Bundle." Final report. January 1983-March 1984. Santa Monica, CA: Dikewood, November 1985. 205p.

Abstract: A deterministic approach based on the variational principle is employed to derive the relationships among the bulk cable current and its individual wire currents. These relationships can be utilized to develop as well as to verify pin specifications of a Line Replaceable Unit (LRU) via direct-drive tests, either onboard an aircraft or in a laboratory. A set of canonical problems involving 2-wire cable over a ground plane is studied in detail to check the derived relationships and to analyze common- and differential-mode current distributions under various conditions. New experiments are suggested to verify as well as to improve the results reported herein.

REPORT NUMBER: AF-WL-TR-84-97
ACCESSION NUMBER: AD-A162 964

Fang, Qiwan and Xaohui Zhang. "Spatial Distribution of the Threshold Beam Spots of Laser Weapons Simulators." Translation of **Chinese Journal of Lasers (China)**, v. 9, no. 5, p. 363-370, 1992. Wright-Patterson AFB, OH: Foreign Aerospace Science and Technology Center, 8 September 1993. 21p.

Abstract: This paper was based on the transmission theory of elliptical Gaussian beam fluxes in deriving some transmission equations for the threshold beam spots of laser weapon simulators, in order to revise and expand the expressions for the threshold beam spots, their maximum range, the extinction function and the irradiance in AD-A102276, and also in this paper, verification test were carried out.

REPORT NUMBER: FASTC-ID (RS) T-0099-93
ACCESSION NUMBER: AD-A269 987

Fessler, E.A. "A Juridical Analysis of Directed-Energy Weapons in the Earth-Space Arena." Master's Thesis. Monterey, CA: Naval Postgraduate School, September 30, 1978. 215p.

Abstract: An intense arms competition between the two superpowers, the Soviet Union and the United States, has been the preeminent challenge to the maintenance of minimum public order since the close of World War II. Through both bilateral arms control negotiations between the superpowers and a variety of related multilateral agreements involving additional state participants, the minimum public order system may recently have been strengthened. Premised upon the assumption that minimum public order is enhanced if strategically significant instruments of coercion are controlled, these initiatives have sought to prohibit or limit arms through restraints upon the size, type, use and even areas of deployment of major weapons systems. These initiatives have assumed that such restraints serve the minimum public order by reducing incentives to compete in research, development and production of advanced weapons of mass destruction. While these efforts have provided at least a minimal restraint on the existing instruments of mass destruction, they have not served particularly well to discourage overall arms competition between major participant states. Evidence is mounting that the specter of a terrifying new mode of warfare designed to function in an expanded earth-space arena has arisen on the technological horizon.

ACCESSION NUMBER: AD-A073 603

Founds, David "Joint Optics Structures Experiment (JOSE)." Kirtland AFB, NM: Air Force Weapons Laboratory, June 1987. 12 p. In: NASA-Langley Research Center NASA/DOD Control/Structures Interaction Technology, 1986, p. 591-602.

Abstract: The objectives of the JOSE program is to develop, demonstrate, and evaluate active vibration suppression techniques for Directed Energy Weapons (DEW). DEW system performance is highly influenced by the line-of-sight (LOS) stability and in some cases by the

wave front quality. The missions envisioned for DEW systems by the Strategic Defense Initiative require LOS stability and wave front quality to be significantly improved over any current demonstrated capability. The Active Control of Space Structures (ACOSS) program led to the development of a number of promising structural control techniques. DEW structures are vastly more complex than any structures controlled to date. They will be subject to disturbances with significantly higher magnitudes and wider bandwidths, while holding higher tolerances on allowable motions and deformations. Meeting the performance requirements of the JOSE program requires upgrading the ACOSS techniques to meet new more stringent requirements, the development of requisite sensors and actuators, improved control processors, highly accurate system identification methods, and the integration of hardware and methodologies into a successful demonstration.

ACCESSION NUMBER: N87-24497

Fraas, A.P. "Effects of Directed and Kinetic Energy Weapons on Spacecraft." Oak Ridge National Laboratory, TN. December 1986. 75p.

Abstract: The characteristics of the various directed energy beams are reviewed, and their damaging effects on typical materials are examined for a wide range of energy pulse intensities and durations. Representative cases are surveyed, and charts are presented to indicate regions in which damage to spacecraft structures, particularly radiators for power plants, would be likely. The effects of kinetic energy weapons, such as bird-shot, are similarly examined. The charts are then applied to evaluate the effectiveness of various measures designed to reduce the vulnerability of spacecraft components, particularly nuclear electric power plants.

REPORT NUMBER: ORNL/TM-9814
ACCESSION NUMBER: DE-87-006015

Frazier, S.J. et al. "Assessing Aircraft Survivability to High Frequency Transient Threats." Patuxent River, MD: Naval Air Warfare Center Aircraft Division, 1994. 7p.

Abstract: Throughout the United States Department of Defense (DoD), the need exists to assess and characterize aircraft system survivability to High Frequency (HF) electromagnetic (EM) transient threats. These threats include the HF Electromagnetic Pulse (EMP) and other ultra wideband (UWB) transient environments. The Navy recognizes this need and is taking the initiative to investigate the feasibility of a realistic, low-cost test methodology to assess, characterize and validate aircraft survivability to threats that may range from a few hundred Kilohertz to the low Gigahertz region. The proposed Navy technical approach is based on established system-level RDTE technology using existing high frequency test laboratories and equipment. The approach will be validated using a combination of High Level Pulse (HLP) testing at the Naval Air Warfare Center Aircraft Division Patuxent Rivers Horizontally Polarized Dipole (HPD) and Vertically Polarized Dipole (VPD) free-field EMP simulators, electromagnetic effects generating equipment to simulate the carrier shipboard environment free-field low-level continuous wave (LLCW) testing to acquire the stress response data, and wideband direct-drive tests to characterize system strength. The Navy is developing a new wideband (up to 1 GHz) direct-drive technology and waveform combination techniques using stress response data to develop worst-case stress envelopes to be used during the direct-drive tests.

ACCESSION NUMBER: AD-A283 999

Freeman, B.L. "Mark 101 Flux Compression Generator: Development Progress." Los Alamos National Laboratory, NM. 1989. 9p. In: International Conference on Megagauss Magnetic Field Generation and Related Topics, Novosibirsk, USSR, 3 July 1989.

Abstract: The Mark 101 explosive flux compression generator is a line-initiated, helical generator that offers the possibility of a theoretical dL/dt greater than or equal to 0.5 omega. The design and initial tests were reported by Fowler, et al. and Freeman, et al. Subsequent to the early results, which demonstrated current gains of only approximately 1.2:1, the generator design

was modified and now includes a low-density foam staging layer between the PBX 9501 explosive and the aluminum armature and a vinyl coating on the stator winding. This redesigned Mark 101 has an initial working inductance of 5.36 mu H and a load inductance of 0.60 mu H. The lossless current gain of this unit is 9.9:1, and the estimated practical gain is approximately 5.5. Experiments have been performed using SF6 and vacuum as the insulating media between the armature and stator. Measured current gains of approximately 5.0:1 have been achieved. The maximum measured dI/dt of approximately 1.2 times 10 sup 11 Amps/sec and V of approximately 62 kV were significantly less than expected during high-current tests. However, a case motion experiment has shown that the armature is probably disintegrating during the last few microseconds of the armature run. Thus, the configuration of the staging layer between the explosive and the armature has been the subject of study. The results of the generator tests are presented.

REPORT NUMBER: LA-UR-89-2080, CONF-8907101-0
ACCESSION NUMBER: DE-89-014298

Friebele, E.J. "Correlation of Single Mode Fiber Fabrication Factors and Radiation Response." Final report. Washington, DC: Naval Research Laboratory, 28 February 1992. 149p.

Abstract: Fiber optic transmission systems, because of their extraordinary channel capacity and decreasing cost, are the preferred terrestrial transmission media of the nation's long distance, inter-city telecommunications infrastructure. Since the commercial telephone network forms the foundation for emergency communication in the event of a national crisis or emergency, additional requirements are placed on the fibers and components of this system. The network must remain operational in the face of such threats as loss of commercial power, disruption by natural causes, violation of physical security, and exposure to the effects of nuclear weapons, including electromagnetic pulse (EMP) and ionizing radiation from the delayed gamma component and fallout. The most stressing environment for the fiber consists of fallout subsequent to a nuclear attack since the long lengths of fiber can be potentially exposed to high total doses. The susceptibility of some types of commercially available fiber optic cable to optical darkening (and hence increased signal loss and bit error rate) from exposure to ionizing radiation raises serious questions about the survivability of such systems in the reconstitution phase of a nuclear conflict.

ACCESSION NUMBER: AD-A247 301

Frost, David J. "Theory for a High Power Free Electron Laser and Tactical Applications." Monterey, CA: Naval Postgraduate School, June 1992. 78p.

Abstract: The free electron laser (FEL) shows potential as a source of coherent, high average power radiation. The achievement of high average power is one of the main topics of current FEL research. This thesis examines the Boeing Average Power Laser Experiment (APLE), whose main goal is to demonstrate the FEL's high average power capability for the first time. The experiment is in the design stage, with completion scheduled for 1996. The first part of this thesis presents a version of a conventional Theater Ballistic Missile Defense (TBMD) system. The advantages of directed energy weapons, specifically the FEL, are also discussed. The remainder of this thesis examines APLE. Chapter V presents research on the oscillator, and Chapter VI deals with the amplifier. Research indicates the current APLE design is feasible and can meet its design goal. Suggestions are presented for optimizing the performance of the oscillator/amplifier system.

ACCESSION NUMBER: AD-A255 161

"FY96 Advanced Weapons Technology Area Plan." Wright-Patterson, AFB, OH: Air Force Materiel Command, 1995. 31p.

Abstract: The Phillips Laboratory (PL) develops and transitions war-fighting technologies in three primary areas: space and missile systems, geophysics, and advanced weapons. This Technology Area Plan (TAP) addresses the third of these three responsibilities, Advanced

Weapons. This Technology Area encompasses the development, demonstration, and transition of advanced weapons; the determination of the susceptibility of USAF systems to similar foreign threats; and the development of protection technology to enhance the survivability of USAF systems. On-going and planned R&D will lead to advanced weapon systems using high energy lasers, high power microwaves, high energy plasmas, and related capabilities such as high resolution optical imaging. Efforts in survivability assessment and protection technology involve the development of both hardening technology and the criteria for protecting USAF systems against directed energy weapons, space debris, and natural and enhanced space radiation.
ACCESSION NUMBER: AD-A349 424

"FY97 Directed Energy Technology Area Plan." Kirtland AFB, NM: Phillips Laboratory, March 1997. 35p.
Abstract: The FY97 Directed Energy Technology Area Plan describes Phillips Laboratory's exploratory and advanced technology development strategy for high power laser weapons, high power microwave weapons, nonlinear optical beam control and imaging, and space systems vulnerability studies survivability techniques in hostile and natural environments.
REPORT NUMBER: PL-TM-97-1001
ACCESSION NUMBER: AD-A323 256

"FY98 Directed Energy Technology Area Plan." Wright-Patterson AFB, OH: Air Force Research Laboratory, 1998. 33p.
Abstract: none available.
ACCESSION NUMBER: AD-A338 003 [also available via DTIC's Fulltext Technical Reports Internet Site]

Galan, L., C. Moranti, F. Rueda and J.M. Sanz. "Study of Secondary Emission Properties of Materials Used for High Power RF (Radio Frequency) Components in Space." Final Report.
Universidad Autonoma de Madrid (Spain). Dept. of Applied Physics, 1988. 86p.
Abstract: Secondary electron emission (SEE) properties of materials used for high power waveguide components in space, particularly on surfaces for space hardware were studied, including Alodine surfaces before and after power conditioning. Surface treatments to aid multipactor suppression for these materials, including methods for surface protection and handling, were examined. If only true SEE is considered, Alodine coatings have better characteristics than TiN, TiC, Cr2O3, and C. The rugosity of Alodine may explain its good properties. No clear correlation between SEE characteristic values and multipactor threshold power is found; smaller SEE is not determinant for obtaining higher multipactor threshold power.
ACCESSION NUMBER: N88-300124

Gandhi, O.P. and J.Y. Chen. "Electromagnetic Pulse-Induced Current Measurement Device." Final technical report. June 1989-September 1990. St. Cloud, FL: Southeastern Center for Electrical Engineering Education, Inc., August 1991. 17p.
Abstract: To develop safety guidelines for exposure to high fields associated with an electromagnetic pulse (EMP), it is necessary to devise techniques that would measure the peak current induced in the human body. The main focus of this project was to design, fabricate, and test a portable, self-contained stand-on device that would measure and hold the peak current and the integrated change Q. The design specifications of the EMP-Induced Current Measurement Device are as follows: rise time of the current pulse, 5 ns; peak current, 20-600A; charge Q, 0-20 micro coulomb. The device uses a stand-on parallel-plate bilayer sensor and fast high-frequency circuit that are well-shielded against spurious responses to high incident fields. Since the polarity of the incident peak electric field of the EMP may be either positive

or negative, the induced peak current can also be positive or negative. Therefore, the device is designed to respond to either of these polarities and measure and hold both the peak current and the integrated charge which are simultaneously displayed on two separate 3-1/2 digit displays. The prototype device has been preliminarily tested with the EMPs generated at the Air Force Weapons Laboratory (ALECS facility) at Kirtland AFB, New Mexico.

ACCESSION NUMBER: AD-A241 946

Gardner, C.L., J.S. Seregelyi and P. Sevat. "Safety Guidelines for the Operation of the DREO 10m EMP Simulator DREMPS." Technical note no. 93-5. Ottawa (Ontario), Canada: Defence Research Establishment, c1993. 42p.

Abstract: A 10m electromagnetic pulse (EMP) simulator was constructed in 1992 to generate the very short pulses of intense electromagnetic fields that would be produced by the explosion of a nuclear weapon outside the atmosphere. Such an explosion would affect military electronic systems. To generate these fields, a 600 kV pulse generator is used. This technical note details the hazards that exist as well as procedures that must be followed to ensure safe operation and maintenance of the facility.

REPORT NUMBER: MIC93-04554

Garner, R. and M. Burka. "Molecular Nitrogen Fluorescence Lidar for Remote Sensing of the Auroral Ionosphere." Technical report. Lexington, MA: PhotoMetrics, Inc., 24 February 1994. 40p.

Abstract: We describe two types of molecular nitrogen fluorescence lidars which can be used to determine excited or ionized Nsub2 density in the ionosphere during moderate or strong aurora. The lidars can also be used for high spatial resolution diagnostics during ionospheric high power radio frequency heating experiments which are often performed when there is moderate auroral activity. The lidars excite Nsub2 already excited or ionized through impact with high energy auroral electrons. Several different configurations are considered for each lidar. The first type of lidar is a conventional fluorescence lidar which operates in the first positive system (Nsub2(A(3)Sigmasubu(+)) yields Nsub2(B(3)Pisubg)) or the first negative system (Nsub2(+)(X(2)Sigmasubg(+)) yields Nsub2(+)(B(2)Sigmasubu(+))). Several different lasers are considered. The choice of laser determines the bands for excitation and fluorescence. The second type of lidar first pumps excited Nusb2 to a higher energy state and then does conventional fluorescence lidar on that state.

ACCESSION NUMBER: AD-A280 716

Gavin, Joseph G., Jr. et al. "Advanced Power Sources for Space Missions." Washington, DC: National Research Council, c1989. 152p.

Abstract: Approaches to satisfying the power requirements of space-based Strategic Defense Initiative (SDI) missions are studied. The power requirements for non-SDI military space missions and for civil space missions of the National Aeronautics and Space Administration (NASA) are also considered. The more demanding SDI power requirements appear to encompass many, if not all, of the power requirements for those missions. Study results indicate that practical fulfillment of SDI requirements will necessitate substantial advances in the state of the art of power technology. SDI goals include the capability to operate space-based beam weapons, sometimes referred to as directed-energy weapons. Such weapons pose unprecedented power requirements, both during preparation for battle and during battle conditions. The power regimes for these two sets of applications are referred to as alert mode and burst mode, respectively. Alert-mode power requirements are presently stated to range from about 100 kW to a few megawatts for cumulative durations of about a year or more. Burst-mode power requirements are roughly estimated to range from tens to hundreds of megawatts for durations of a few hundred to a few thousand seconds. There are two likely energy sources, chemical and nuclear, for powering SDI directed-energy weapons during the alert and burst modes. The choice between chemical and nuclear space power systems depends in large part on the total duration during which power

must be provided. Complete study findings, conclusions, and eight recommendations are reported.

REPORT NUMBER: NASA-TM-101811
ACCESSION NUMBER: N89-28565/AD-A345 765

Gay, Jeffery M., James B. Cornette and Mark W. Heyse. “Electromagnetic Launcher Control Using Finite State Machines.” Final Report. March 1991 – April 1992. Eglin AFB, FL: Wright Laboratory, Armament Directorate, July 1992. 11p.

Abstract: This paper shows the continued viability of sequential Finite State machines (FSMs) as a means to control the sequencing of Electromagnetic Launcher (EWE) systems. While computer control led sequencing is an attractive alternative FSMs are easy to design, inexpensive and reliable. Several FSM controllers are currently in use for the long duration EML experiments at the Hypervelocity Research Facility, Eglin AFB, FL. This paper discusses the basic system design with reference to design procedure and systems interfacing, flexibility, and the fail-safe nature of the FSM (i.e., system interrupt capability) are also discussed. Where requirements include repeatability, reliability, ease of operation, relative low cost, and flexibility, the FSM is presented as a reasonable alternative to more expensive computer-based systems.

REPORT NUMBER: WL/MN-TR-92-006
ACCESSION NUMBER: AD-A254 433

Gedik, Abdullah. “Energy Threshold For Laser Induced Breakdown on a Metal Surface Under High and Ultra High Vacuum Conditions.” Monterey, CA: Naval Postgraduate School, June 1991, 38p.

Abstract: Unipolar arcing is the primary breakdown process when a powerful laser pulse interacts with a target surface. The unipolar arc model assumes that the initial ionization occurs in desorbed gas layers. To check this experimentally a metal surface was illuminated under different vacuum conditions. The experiments were conducted at 10-4, 10-6 and 10-8 torr vacuum. A neodymium:glass laser of wavelength 1.06 um in the Q-switched mode was utilized. Type 304, polished, stainless steel plates were used as targets. Results confirmed that higher laser energy was needed to trigger the laser induced breakdown at lower pressures.

ACCESSION NUMBER: AD-A246 212

George, W.V., W.R. Sooy and M.A. Summers. “Army Boost Phase Intercept Initiative.” Livermore, CA: Lawrence Livermore National Laboratory, 28 July 1995. 2p.

Abstract: No abstract available.

REPORT NUMBER: UCRL-ID-121803
ACCESSION NUMBER: DE-96-003822

Girolamo, Henry. “Notional Helmet Concepts: A Survey of Near-Term and Future Technologies.” Army Natick Research and Development Center, MA. March 1991. 60p.

Abstract: This research identified, explored , and evaluated near-term and future technologies having potential applications in developing a future helmet- mounted display and an integrated battlefield communication/information management system that will enhance the dismounted soldier’s performance. This report was written with the combat developer in mind and is intended to serve as a technology guide. Helmet-mounted displays would have a multi-purpose full-face shield capable of displaying alphanumeric data and graphics. It would need a polycarbonate resin that would provide protection against ballistic fragmentation and directed energy hazards. The display would include night vision enhancement capabilities and electro-optical weapons sights

for remote weapon sighting; sensors to medically monitor the soldiers physiological functions; and sensors that would warn soldiers of chemical and biological agents, radiation, and other hazardous atmospheric conditions.

REPORT NUMBER: NATICK/TR-91/017
ACCESSION NUMBER: AD-A234 475

Godfrey, B.B. "Microwave and Electron Beam Computer Programs." Final report. August 1986-January 1988. Albuquerque, NM: Mission Research Corp., June 1988. 31p.

Abstract: This report discusses some computer programs available for addressing the physics of high power microwave and charged particle beam generation and propagation. Codes range from simple lumped parameter models to detailed multidimensional simulations. Described here are the capabilities and underlying models of the microwave source, particle beam accelerator, and particle beam propagation codes. Although the more powerful of these programs can also be used for microwave propagation and antenna design, other programs specifically designed for these applications are typically employed instead.

REPORT NUMBER: AF-WL-TR-87-69
ACCESSION NUMBER: AD-A197 798

Godfrey, B.B. et al. "IFR Transport in Recirculating Accelerators." Final report. Albuquerque, NM: Mission Research Corp., November 1985. 52p.

Abstract: Charged particle beam weapon research has focused on predictions of RADLAC beam propagation in the atmosphere, analysis of RADLAC beam transport in low density ionized (IFR) channels, and preliminary studies of generic IFR transport in recirculating high current electron beam inductive accelerators. This report summarizes our recirculating accelerator findings. In addition, a patent disclosure for creating IFR channels with low power electron beams has been prepared in collaboration with SNL personnel.

ACCESSION NUMBER: AD-A229 102

Goldstein, G.R. "Free Electron Lasers as Ground Based Space Weapons." MIT, Cambridge, MA: MIT, 1988. In: Third Short Course on the Arms Race, Washington, DC, 16-17 April 1988, AIP Conference Proceedings, no.178, p. 290-315

Abstract: The free electron laser (FEL) is the most promising directed energy weapon in the SDI program. Its theoretical underpinnings, present achievements and future prospects are reviewed. The general requirements of a ground based laser system are derived and are seen to be quite expensive to implement as well as being far beyond current technical capabilities. Atmospheric propagation effects, particularly stimulated Raman scattering, will make the transmission of adequate powers dubious. A summary of existing and proposed FEL parameters shows that, at best, future facilities ill be many orders of magnitude away from the required GigaWatt average output powers in the visible or near infrared region. Prospects for FEL midcourse or terminal phase weapons are equally problematic, given the simple countermeasures available to the offense. Use as an ASAT weapon is less technically demanding, but of limited applicability given the vulnerability of an extensive space based targeting system.

Goto, S.K. and J.H. Hayden. "Multimegawatt Power Distribution Considerations." In: IECEC '86; Proceedings of the Twenty-First Intersociety Energy Conversion Engineering Conference, San Diego, CA, August 25-29, 1986. Volume 3. Washington, DC: American Chemical Society, 1986, p. 1660-1662.

Abstract: Strategic Defense Initiative (SDI) power systems are required to operate at low power for extended periods, yet provide burst power of hundreds of megawatts for up to hundreds of seconds for electromagnetic launchers and various directed energy weapons. High power levels

and the separation between the prime power source and the weapon because of the physical size of each makes the design of the electrical power transmission and distribution system of great significance. Preliminary analysis of SDI power system architectures indicate that power distribution equipment and its thermal control are significant portions of the total spacecraft weight. It appears that proper choice of distribution voltage and conductor material can significantly reduce the total system mass by eliminating all active thermal control systems and allowing conductor temperatures to rise during the engagement. This paper examines several concepts to minimize distribution system weight.

Gover, J.E. and J.S. Browning. "Radiation-Hardening Systems Considerations: Electrical Systems and Radiation Environments." Albuquerque, NM: Sandia National Labs., March 1987. 65p.

Abstract: This report describes the classes of electrical systems that require the use of radiation-hardened microelectronics and presents the characteristics of the radiation environments. We anticipate that developers of systems that are to be radiation-hardened can use this report to better appreciate the issues involved. In particular, we wish to emphasize the need for considering radiation-hardening issues early in systems development.

REPORT NUMBER: SAND-86-1737
ACCESSION NUMBER: DE-87-007821

Granatstein, V.L. et al. "Soviet High-Power Radio Frequency Research." McLean, VA: Science Applications International Corp., July 1988. 153p.

Abstract: A panel of U.S. scientists and engineers assessed Soviet research in high powered microwaves in the early 1980s, as reflected in information released publicly. In the centimeter band, the USSR is far ahead of the U.S. in developing backward wave oscillators (BWOs) at extremely high peak power levels and high efficiency. Soviet scientists are also far ahead in developing repetitively pulsed BWOs and magnetrons, and in compact packaging of these repetitively pulsed generators. In high power millimeter wave devices, Soviet capability is at the forefront in gyrotron development, but lags in free electron laser experiments. Soviet research on gyrotron amplifiers aimed at providing radio frequency power for linear supercolliders has produced a 60 dB amplifier at 7 GHz capable of producing 60 MW output pulses of 0.7 microsec duration. An almost complete absence in recent USSR literature on vircators or on phase locking of high power microwave sources is noted. Only one publication on high power microwave component development or high power microwave propagation was found in recent USSR literature. No mention of testing electronic components for damage by high microwaves was found, although references were made to effects of nuclear electromagnetic pulses.

ACCESSION NUMBER: N89-136873

Grant, J.E. "Fiber-Optics Used to Record High-Speed Photographs Inside a Pressurized Tank During Lethality Testing." Albuquerque, NM: Sandia National Labs., April 1988. 32p.

Abstract: Sandia National Laboratories has a program underway to determine the survivability and lethality of potential targets subjected to high order impulse loads. This effort is associated with the Strategic Defense Initiative's (SDI) Directed Energy Weapons (DEW) program and is managed by the Defense Nuclear Agency (DNA). The energy from this class of weapons impact the target surface simultaneously and produce an impulse that varies as the cosine of the angle of incidence. The goals of the program are to determine the relevant failure mechanisms, assess the validity of our numerical codes in modeling target behavior, provide a series of benchmark tests that can be used to improve our numerical capability, and provide the SDI community with estimates of survivability and lethality levels for various generic targets. The experiment described in this report is one in a series of similar experiments designed to model target behavior in the absence of material degradation and spall.

REPORT NUMBER: SAND-88-8205

ACCESSION NUMBER: DE-88-011283

Graybill, R. "Chemical and Laser Sciences Division Annual Report 1990." Progress report. Los Alamos National Laboratory, NM. June 1991. 132p.

Abstract: This is the annual report of the Chemical and Laser Sciences Division at Los Alamos National Laboratory for 1990. Topics covered include analytical chemistry research, inertial confinement fusion, free electron lasers, and directed energy weapons.

REPORT NUMBER: LA-12107-PR
ACCESSION NUMBER: DE-91-014302

Griff, Neil. "Directed Energy Overview." In: High-Power Gas Lasers; Proceedings of the Meeting, Los Angeles, CA, January 15-17, 1990. Bellingham, WA: Society of Photo-Optical Instrumentation Engineers, 1990. p. 601-628.

Abstract: Directed energy weapons can add significantly to the effectiveness of a Strategic Defense System (SDS) by complementing the capability of phase I kinetic energy weapons. Component development for each of the directed energy concepts is progressing well. The chemical laser and neutral particle beam programs are nearing the stage where component integration tests are essential for establishing engineering proof-of-principle. For the somewhat less mature ground-based free electron laser technology, device development will be emphasized during the next several years. Development of the acquisition, tracking and pointing (ATP) program will continue at a fast pace, with an exciting proof-of-principle information to support a national decision on strategic defense in the 1991/1993 timeframe.

Gripshover, R.J. and L.F. Rinehart. "Frozen Wave Generator Jammer." Patent. Washington, DC: Department of the Navy. Filed 9 April 1981. Patented 1 January 1985. 10p.

Abstract: A high peak power, broad band, radio frequency pulse generator generates square wave pulses at a high pulse repetition frequency for use in jamming of radar, data links, voice communication, or other radio frequency signals. The generator is constructed with one or more pairs of coaxial cable formed into opposite half loops. The cable is provided with an inner conductor and outer conductors with the outer conductor of each opposed loop attached to a spark gap switch while the inner conductor is continuous throughout the loops from one side of a matched impedance load, such as an antenna, to the other side of the load. The spark gap switch is provided with a pair of electrodes separated by a gap. The gap contains a dielectric medium having fast spark quenching characteristics and a high standoff voltage. Peak power for the generator is 10 to 100 kilowatts with a pulse repetition frequency of 1 to 100 kilohertz.

PATENT: 4,491,842

Grossman, J. "Military Laser Systems." Santa Monica, CA: Rand Corp., January 1991. 21p.

Abstract: The article reviews the military interests that created the diversity of laser systems, describes some of the more significant developments, and discusses some of the military lasers that can be expected in the future. Military interests in laser systems has been concentrated in four general areas: laser rangefinders and target designators; directed energy weapons (DEWs); laser radar; and laser communications. The nature of this interest is, for the most part, significantly different from that in the commercial world. This does not mean there are no commercial spinoffs of military laser technology. DoD funding, as we will discuss in this article, has enabled significant laser systems to be advanced from laboratory curiosities to reliable and relatively inexpensive commercial successes.

REPORT NUMBER: RAND-P-7704
ACCESSION NUMBER: PB-93-142230

Grotz, T. “Development of Particle Beam Weapons Based on Nikola Tesla’s Design of 1937.” Craig, CO: Tesla Corp., 1991. In: IECEC-91. Proceedings of the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, 4-9 August 1991. p. 410-415. vol. 4.

Abstract: The author detailed the design of Telsa’s particle beam weapon system and described current experiments presently being funded by the US Department of Defense. Tesla’s invention was simply a particle beam weapon, which he proposed in 1937. It used electrostatic propulsion techniques and novel methods of generating and controlling high voltages. Similar devices are being developed today by the Strategic Defense Initiative Organization (SDIO) and the US Army Strategic Defense Command. The successful carrying out of the plan involves a number of more or less important improvements., but the principal ones among these area the following: a new form of high vacuum tube open to the atmosphere; provisions for imparting to a minute particle an extremely high charge; a new terminal of relatively small dimensions and enormous potential; and an electrostatic generator on a new principle and of very great power. These devices and methods of operation are explained.

“GTA (Ground Test Accelerator) Phase 1: Baseline Design Report.” Los Alamos National Laboratory, NM. August 1986. 436p.

Abstract: The national Neutral Particle Beam (NPB) program has two objectives: to provide the necessary basis for a discriminator/weapon decision by 1992, and to develop the technology in stages that lead ultimately to a neutral particle beam weapon. The ground test accelerator (GTA) is the test bed that permits the advancement of the state-of-the-art under experimental conditions in an integrated automated system mode. An intermediate goal of the GTA program is to support the Integrated Space Experiments, while the ultimate goal is to support the 1992 decision. The GTA system and each of its major subsystems are described, and project schedules and resource requirements are provided.

REPORT NUMBER: LA-UR-86-2775
ACCESSION NUMBER: DE-87-007838

Gullickson, Richard L. “Directed Energy Space Experiments for Strategic Defense.” In: EASCON ’87; Proceedings of the Twentieth Annual Electronics and Aerospace Systems Conference, Washington, DC, October 14-16, 1987. New York, NY: Institute of Electrical and Electronics Engineers Inc., 1987, p. 33-42.

Abstract: Experiments in space are necessary to validate the technologies developed in SDIO’s directed energy programs. High energy lasers, neutral particle beams, relay/mission mirrors, and ATP (acquisition, tracking, pointing) systems are being developed for space operation. Laboratory demonstrations with these technologies are a necessary but not a sufficient condition upon which to base system development decisions. By the early 90’s, SDIO plans to have conducted experiments in space on each of these key directed energy technologies.

Guo, Theodore C. and Wendy W. Guo. “Transient Interaction of Electromagnetic Pulses in Dielectrics and Microwave Biophysics.” Final report. 1 June 1985-30 May 1988. Washington, DC: Catholic Univ. of America, Dept. of Physics, 12 May 1988. 70p.

Abstract: Due to recent progress in developing equipment that can generate short microwave and millimeter wave pulses, there has been an increasing proliferation of microwave pulse transmitters, some with short pulse width (0.1 microsecond) and extremely high intensity (100-1000 megawatts). Microwave pulse transmitters are used extensively by the military for communication and remote control; using microwave pulses as directive energy weaponry and as means of transporting energy has also been contemplated. Electromagnetic pulses (EMP) are

also emitted in nuclear blasts and from EMP simulators. All this production of microwave pulses affects the operation of military personnel in non-combat environment as well as in battle fields. Therefore minimizing microwave damage is central to successful operations of all military units. Understanding basic interactions between microwave pulses and dielectric materials will contribute greatly to the protection of human subjects from microwave damage and to the development of preventive measure.

ACCESSION NUMBER: AD-A196 838

Gupta, Avanindra A. and Lawrence M. Germann. “Precision Pointing and Inertial Line-of-Sight Stabilization Using Fine-Steering Mirror, and Strap-Down Inertial Sensors.” In: Guidance and Control 1989; Proceedings of the Annual Rocky Mountain Guidance and Control Conference, Keystone, CO, February 4-8, 1989. San Diego, CA: Univelt, Inc., 1989, p. 325-336.

Abstract: In many space-based pointing and tracking applications, the pointing system must be stabilized using inertial references and the optical feedback signal is either unavailable or too low bandwidth, due to uncooperative targets or background clutter, to provide position reference to the pointing system. This paper presents results of the analyses and simulations for a pointing system configuration based on the body-fixed telescope concept to show that microradian-pointing, jitter system can be designed using inertial references from star trackers, accelerometers, and gyros for directed-energy weapons, surveillance, optical seekers, and laser communication.

REPORT NUMBER: AAS Paper 89-036

Guptia, Vijay. “Measurement of Interface Strength, Intrinsic Toughness and Their Dependence on Interfacial Segregants.” Final Report. 31 March 1991- 15 September 1994. Hanover, NH: Thayer School of Engineering, 26 December 1994. 44p.

Abstract: This report discusses a novel laser spallation technique for measuring the tensile strength of planar thin film interfaces. In this technique, a laser-produced compressive stress pulse in the substrate, reflecting from the coating’s free surface pulls the interface in tension and leads to its failure if the tensile amplitude is high enough. The interface stress is determined by recording the coating or substrate free-surface velocities using a Doppler interferometer. Interface strengths of several metal/ceramic, ceramic-ceramic and ceramic/polymer systems are summarized from our recent efforts. In addition, two breakthroughs, the first of a novel interferometer to record velocities from rough surfaces and the second of a technique to produce subnanosecond rise-time stress pulses with no asymptotic post-peak decay, are discussed which further allows the technique to be applied to rough thermal spray coatings and also to films as thin as 0.1 um. This technique is used to establish a fundamental strength-structure chemistry relationship for Nb/sapphire interfaces, with and without the interlayers of Cr and Sb. This allows the interface strengths to be controlled over a wide range, as required for realizing the strategy of deflecting impinging matrix cracks along the fiber/matrix interfaces so as to impart toughness in otherwise brittle composites. The required values of fiber/matrix interface toughness needed for crack deflection were obtained by using the method of dual singular equations. Finally, in a separate study, the short stress pulses are used to determine the dynamic response of laminates, and preliminary results are presented that show their potential in evaluating the damage in composites in a nondestructive mode.

ACCESSION NUMBER: AD-A291 798

Haaland, C.M. “Shadow of Ground Zero.” Oak Ridge National Laboratory, TN: 1984. 22p.

American Civil Defense Association Annual Meeting, Daytona Beach, FL. 15 November 1984.

Abstract: The history of the development of nuclear weapons starting with the detonation of the A-bombs on Japan is reviewed. An overview of nuclear weapon effects is presented. The effects of electromagnetic pulse (EMP), initial nuclear radiation, thermal radiation and blast are discussed with reference to how people outside can survive when ground zero is only a few miles away.

REPORT NUMBER: CONF-84-111221
ACCESSION NUMBER: DE-85-003505

Haas, Gary A. and James J. Spangler. "An Implementation of the Multiple Integrated Laser Engagement System (MILES) on an Unmanned Ground Vehicle (UGV)." Aberdeen Proving Ground, MD: Army Research Laboratory, March 1996. 30 p.

Abstract: This report describes the use of the Army's multiple integrated laser engagement system (MILES), as installed on an unmanned ground vehicle (UGV), for a field training exercise with armored scouts of III Corps First Cavalry Division. The electronic circuitry interfacing the MILES to the UGV is described in detail. The report includes tutorial material about MILES and a brief description of Project Mustang.

REPORT NUMBER: ARL-TR-1062
ACCESSION NUMBER: AD-A308 456

Harkins, Richard M. "Target Voltage Response in Reaction to Laser Radiation." Monterey, CA: Naval Postgraduate School, December 1988. 73p.

Abstract: The five microsecond, 15 joule, pulsed CO2 Laser was used to irradiate polished 2024 aluminum targets. The target voltage response (TVR) was measured with respect to the incident laser radiation and showed a pulse width on the order of 30 nanoseconds. The voltage was measured at values form 22 to 140 volts with resistances varying form one ohm to two mega-ohms. The TVR was correlated to the emission and blow-off of electrons form the target surface and the possible ignition of a Laser Supported Detonation wave. The TVR, laser pulse, and flash associated with target surface breakdown were time correlated and shown to happen within the first 170 nanoseconds of the five microsecond laser pulse. Currents up to 500 amps were observed when the resistance to ground was reduced to less than 1 ohm. Also, the magnitude of the TVR was shown to be a function of background gas pressure.

ACCESSION NUMBER: AD-A205 256

Hartmann, Francis X., et al. "Intense Laser-Matter Interactions. An Approach to Laser Driven Electronic and Nuclear Energy Transfer." Final report. October 1986-October 1987. Alexandria, VA: Institute for Defense Analyses, August 1988. 61p.

Abstract: A semiclassical model treating the interaction of an intense laser field with a non-radiatively coupled system is developed. The model is applied to laser-electron-nuclear energy transfer in a simple single particle model. Results from an initial series of runs on an illustrative example, as reported in conferences and the open literature, are summarized. The work is of ultimate interest in excitation of low-energy nuclear transitions for isotope separation, examination of a laser triggered isotropic gamma-source, or, with extensions, laser damage studies.

REPORT NUMBER: IDA-D-406
ACCESSION NUMBER: AD-A224 787

Hasti, D.E. "Endoatmospheric Propagation Experiments and Accelerator Development." Albuquerque, NM: Sandia National Labs., 1987. 4p. SDIO/DARPA Services Annual Propagation Review, Monterey, CA. 29 September 1987.

Abstract: The RADLAC program encompasses high power electron beam propagation experiments and accelerator development, both for advanced propagation experiments and to develop compact accelerator options for future charged particle beam weapons (CPBW). Propagation experiments include conditioning cell and lead pulse stability (LPS) experiments on RADLAC II, and channel-tracking experiments on IBEX. The RIIM accelerator was used for two-pulse accelerator experiments to explore two-pulse configurations for RADLAC II. The ion focused regime (IFR) transported, recirculating linear accelerator (RLA) experiment is aimed at future CPBW compact accelerator development. This paper briefly outlines recent work in these areas.

REPORT NUMBER: SAND-87-2341C, CONF-87-091468
ACCESSION NUMBER: DE-88-000928

Hasti, D.E. "RADLAC Summary." Albuquerque, NM: Sandia National Labs., 1986. 6p. In: DARPA Conference, Albuquerque, NM. 23 June 1986.

Abstract: RADLAC program activities are reviewed. The work is broadly categorized under lead pulse stability (LPS), channel tracking, and Recirculating Linear Accelerator (RLA) activities. In LPS activities, stable, open-air propoagation of the RADLAC-II beam was demonstrated over ranges longer than a Nordsieck length. These shots were coordinated with the activities of other experimenters measuring beam induced emissions, and demonstrated that RADLAC II could be fired on a predetermined schedule to allow numerous, coordinated, and geographically widespread measurements to be made. Since those experiments, improvements in the RADLAC II accelerator, ion focus regime (IFR) beam conditioning cells, and matching of the accelerator beam to those cells have produced a beam which should allow greater than 20 betatron wavelengths in a Nordsieck length and saturation of hose growth to be observed. Channel tracking activities have included continued hardware development on the RADLAC-II Module (RIIM) for pulse-to-pulse channel tracking, the design of a laser for conductivity channel tracking, and demonstration of a crude beam director for a high current beam. Codes which allow channel tracking simulations to be done have also been developed. Pulsed power and beam transport experiments on the Recirculating Linac have led to hardware and techniques which will allow demonstration of beam recirculation of a high current beam this year and a recirculating linear accelerator next year. These transport schemes and pulsed power developments can be extended to higher energies and a conceptual RLA for Navy charged particle beam weapon (CPBW) applications has been developed.

REPORT NUMBER: SAND-86-1593C, CONF-86-061534
ACCESSION NUMBER: DE-86-012946

Herrick, Dan, Jack Rodden and Paul Shirley. "End-to-End Control System Verification of the STARLAB Experiment." San Diego, CA: American Astronautical Society, Rocky Mountain Section, February 1990. 16p. Presented at the Annual Rocky Mountain Guidance and Control Conference, Keystone, Colorado, February 3-7, 1990.

Abstract: This paper describes an electro-optical tracking and beam control system simulation used to analyze the performance for the space shuttle based STARLAB experiment hardware. STARLAB is to provide an on orbit demonstration of acquisition, tracking and pointing (ATP) techniques critical to strategic defense directed energy concepts. In particular, a target booster will be optically tracked from launch to re-entry. This rocket will be instrumented to "score'1 how accurately a laser beam can be pointed by the experiment. This paper focuses on techniques used to predict on-orbit performance based on laboratory testing and simulations.

REPORT NUMBER: AAS-90-045
ACCESSION NUMBER: AD-A339 434

Herrmannsfeldt, W.B., A.M. Sessler and J.R. Alonso. “Proceedings of a Workshop on Applications of Accelerators.” Stanford Linear Accelerator Center, CA, 31 January 1994. 84p. In Workshop on Applications of Accelerators, Stanford, CA, 1-2 December 1993.

Abstract: This document is a compilation of material collected as the results of a workshop, Applications of Accelerators, held at the Stanford Linear Accelerator Center, 1--2 December 1993. The material collected here has been edited for style and to minimize duplication. Footnotes will identify the original source of the material. We believe that the reader will find that this document has something for every interest. There are applications in the fields of health, food preservation, energy, environmental monitoring and protection, and industrial processing. Many of the examples discussed have already passed the demonstration stage. Most of the others are the subject of active accelerator research. Taken as a whole, the particle accelerator field contains a wealth of application opportunities, some already in use, and many more ready to be exploited.

REPORT NUMBER: SLAC-430, LBL-35023, CONF-93-1248
ACCESSION NUMBER: DE-94-008435

Heyse, Mark W., James B. Cornette, and Jere L. Brown. “An Investigation of Electromagnetic Launcher Repeatability.” Final Report. March 1991 – April 1992. Wright-Patterson AFB, OH: Wright Laboratory, July 1992. 13p.

Abstract: Electromagnetic launcher (EML) performance repeatability has been identified as a potential development issue for several years. Investigation of this issue has been difficult because an EML that is powered on a relatively continuous basis to provide long duration operation has not been available. A battery charged capacitor power system has enabled long duration, 6 to 7 seconds, EML experiments. This paper provides a summary of an experiment to investigate EML launch to launch performance consistency. A series of 8 ten-shot bursts, each separated by 15 to 30 minutes, performed in a single day using a single set of bore materials is the subject of this paper.

REPORT NUMBER: WL-TR-92-009
ACCESSION NUMBER: AD-A254 339

Hietala, V.M et. al. “Optical Generation of Radio-Frequency Power.” Albuquerque, NM: Sandia National Labs., November 1994. 38p.

Abstract: An optical technique for high-power radio-frequency (RF) signal generation is described. The technique uses a unique photodetector based on a traveling-wave design driven by an appropriately modulated light source. The traveling-wave photodetector (TWPD) exhibits simultaneously a theoretical quantum efficiency approaching 100 % and a very large electrical bandwidth. Additionally, it is capable of dissipating the high-power levels required for the RF generation technique. The modulated light source is formed by either the beating together of two lasers or by the direct modulation of a light source. A system example is given which predicts RF power levels of 100's of mW's at millimeter wave frequencies with a theoretical "wall-plug" efficiency approaching 34%.

REPORT NUMBER: SAND-94-2761
ACCESSION NUMBER: DE-95-005276

“High-Power Microwave Development in Russia.” Ottawa (Ontario), Canada: Department of National Defence, March 1995. 12p. In: AGARD, High Power Microwaves (HPM), Volume 1. 12p.

Abstract: This is a survey of Russian research and development in high-power microwave (HPM) sources. It emphasizes those sources of nanoseconds pulse duration time which have potential weapon as well as radar applications. It does not cover the whole range of Russian HPM research and development but concentrates on those aspects which may lead to military applications. Russian investigators have

achieved many world firsts in HPM generation; for example, a multiwave Cerenkov generator with a peak output power of 15 gigawatts. Their successes are based on their impressive capability in pulsed power technology which has yielded high-current generators of terawatt peak power. They have transformed the energy of these currents into microwave radiation using tubes of both conventional and novel designs exploiting relativistic electron beams. Recently, the development of high-current mini-accelerators has moved relativistic electron-beam (REB) HPM generation out of the laboratory and enabled the development of deployable military systems with peak powers in the gigawatt range. As a result, they now see development of a REB-based radar systems as one of the most promising directions in radar systems. Details of such a system are described and the implications for HPM weapons are considered.

ACCESSION NUMBER: N96-138623

"High Power Microwave Hazard Facing Smart Ammunitions." Diehl G.m.b.H. und Co., Roethanbach (Germany). Optoelectronics Division, March 1995. 12p. In: AGARD, High Power Microwaves (HPM), Volume 1. 12 p.

Abstract: The battle field of the present and even more the one in future will be characterized by the use of weapon systems with a high degree of electronics, computers, and sensors, designed and built to keep not only the man out of the loop. But the higher the technology used for smart weapon systems, the more these systems are endangered by numerous sources of hazard. One of those sources is the threat caused by induced or natural electromagnetic fields. These threat factors can be generated by natural, civil and military environment. In principle there are two main applications which must be considered in military applications: Firstly, weapon systems, that is, high power microwave sources as well as intelligent electromagnetic radiation systems to defeat ammunition on the battle field and secondly, the hardening of the own smart ammunition systems and missiles against the interference sources created by the different types of electromagnetic fields. This report will discuss the possible electromagnetic coupling effects on smart ammunition and missiles and their typical interference caused on the electronics and sensor level. Real time 6-DOF simulations show the flight mission which may be compromised depending on the coupled electromagnetic fields. The German MOD has established a research program where smart ammunitions with different seeker systems are investigated in respect of the coupling effects on smart ammunition caused by high power microwaves. This program considers all available resources and know how in Germany. The systems are investigated by analytical, numerical, and experimental methods with passive and activated missiles.

ACCESSION NUMBER: N96-138730

Hoffert, Martin I. "Innovative Energy Conversion Schemes for Space Based Strategic Defense Systems." New York: New York University, Department of Applied Science, January 1988. 31p.

Abstract: A major objective of the Strategic Defense Initiative research program is the development of technologies capable of destroying fleets of ICBM's in the boost phase of their mission by directed energy weapons, perhaps based on a constellation of orbiting satellites or Battle Stations. A strategic defense system may therefore be viewed as a series of energy conversion steps terminating in the deposition of a "lethal" energy flux on ballistic targets above the sensible atmosphere, together with an information-handling system for tracking, aiming and finding at these targets. Although these are stringent requirements, a number of potentially effective strategic defense concepts are under evaluation employing fleets of satellites at 200-1000 km altitudes in near-polar orbits. Baseline power requirements for these satellites which have been cited are continuous onboard power at the 10 kW level, and intermittent power at the 10-1000 MW level for perhaps tens of seconds when directed energy devices are energized. Despite their high power requirements, chemical energy sources for directed energy bursts appear feasible because the durations are short. But the more prosaic 100 kW level housekeeping power cannot be generated chemically for durations longer than a few days without unacceptably large mass to orbit, or unless the fuel is regenerated by an external energy source.

REPORT NUMBER: NYU/DAS-88-001

ACCESSION NUMBER: AD-A338 958

Hoffman, Terance J. “Experimental and Analytical Analysis of the Response of a Smart Beam to Rate Feedback.” Wright-Patterson AFB, OH: Air Force Inst. of Tech., School of Engineering, June 1993. 139p.

Abstract: A smart beam with embedded sensors and actuators was analyzed and tested. The smart beam studied was constructed from graphite and epoxy with piezoceramic actuators and NiTiNOL sensors embedded. It was mounted vertically and subjected to transverse dynamic loading at the free end. Analytic expressions for the open loop and closed loop response (using strain rate feedback control) of the beam (including internal damping) to external forcing were derived in detail. Experimental testing of the beam, verified the accuracy of the predicted open loop response.... Smart beams, Piezoceramic actuators and NiTiNOL sensors.

REPORT NUMBER: AFIT/GA/ENY/93J-01
ACCESSION NUMBER: AD-A266 544

Hong, Xingliu, Sangchuan Jiang and Zhiyong Wei. “Star Wars and Beam Weapons.” National Air Intelligence Center, Wright-Patterson AFB, OH. 21 September 1995. 463p. Translation of **Xingdiu Dazhan Yu Shuliuwuqu**, Lanzhou University (China), 1-5, March 1989.

Abstract: No abstract available.

REPORT NUMBER: NAIC-ID (RS) T-0131-95
ACCESSION NUMBER: AD-A300 665

Hoppler, D.E. “Department of Energy Strategic Defense Initiative Programs: Potential Programmatic and Facility Impacts Due to a Prospective Defense and Space Treaty.” McLean, VA: Science Applications International Corp., 10 May 1990. 35p.

Abstract: The objective of the following paper is to provide the DOE an analysis of the potential, but reasonably expected, impacts on DOE SDI-related programs resulting from alternative Defense & Space Treaty/Protocol outcomes. DOE facility impacts due to the implementation of Predictability and Confidence-Building Measures currently under negotiation will also be examined.

REPORT NUMBER: DOE-DP-50066-T-6
ACCESSION NUMBER: DE-90-012717

Hughes, R.J. and W.B. Cottingame. “Geomagnetic Trapping and Prompt Detection of Protons from an Orbital Neutral Particle Beam.” Los Alamos National Laboratory, NM. October 1991. 34p.

Abstract: Copious quantities of protons are emitted during the operation of a neutral-particle-beam (NPB) accelerator system. If the system is operated in Earth orbit, these protons have the potential for becoming trapped in the Earth's magnetic field. In this paper, the evolution of the proton population at short times after injection from an NPB platform of modest capability operated at low altitudes and low latitudes is studied. In particular, protons that are injected below the intense proton radiation belts and that have lifetimes long enough to allow them to survive many drift periods are considered. The probability of intercepting these trapped protons and the magnitude of the associated flux within a few drift periods of injection are estimated. The possibility of monitoring the space environment for the characteristic signals of such trapped protons is discussed as a method for detecting the operation of an NPB in low-Earth orbit.

REPORT NUMBER: LA-12150-MS

ACCESSION NUMBER: DE-92-000659

Iversen, S.G. et al. “Charged Particle Beam Divergence Measurements Using Transition Radiation.” Goleta, CA: EG and G Energy Measurements, Inc., Santa Barbara Operations, 1987. 4p. In: Particle Accelerator Conference, Washington, DC, 16 March 1987.

Abstract: Developed is single and double foil techniques to measure current density, energy, and divergence of intense relativistic charged particle beams from the transition radiation produced at a foil-vacuum interface. Single foil optical transition radiation (OTR) measurements have been made using a high intensity beam of 10 to 25 MeV electrons from the EG and G/EM linac, in which the entire OTR distribution is captured with an imaging system. Here we describe the results of similar experiments utilizing a two-foil interferometer, which has potential for making high precision energy and emittance measurements of very cold beams.

REPORT NUMBER: LA/UR-87-1967, CONF-87030223-2
ACCESSION NUMBER: DE-87-011780

Jameson, R.A. “High-Brightness H sup - Accelerators.” Los Alamos National Laboratory, NM. 1987. 6p. In: Particle Accelerator Conference, Washington, DC, 16 March 1987.

Abstract: Neutral particle beam (NPB) devices based on high-brightness H sup - accelerators are an important component of proposed strategic defense systems. The basic rationale and R and D program are outlined and examples given of the underlying technology thrusts toward advanced systems. Much of the research accomplished in the past year is applicable to accelerator systems in general; some of these activities are discussed.

REPORT NUMBER: LA-UR-87-666, CONF-8703024-4
ACCESSION NUMBER: DE-87-007464

Jensen, et al. “Tactics and Technology: How Do they Affect Each Other?” Washington, DC: Marine Corps, 1 April 1991, 33p.

Abstract: Research and development of new, revolutionary technologies have been extensive. The resulting military applications will drastically change the tactical nature of the battlefield. To cover every technology currently under consideration would be lengthy and beyond the scope of this paper. Rather, it is the intent of this paper to detail selected technological innovations and their tactical implications. Technological advances in space research will allow us to (1) reduce the reaction time in engaging adversary’s ballistic missiles by employing boost-phase monitoring technology; (2) establish an overall command and control network for Ballistic Missile Defense (BMD) by incorporating all of our assets into an overall surveillance and tracking system; (3) engage incoming ballistic missiles in a variety of ways, using directed-energy and kinetic energy weapons, both ground and space based; and (4) engage the adversary’s satellites from ground, space, and aerial-based means, hampering his ability to use satellite systems for surveillance, reconnaissance, and communication.

ACCESSION NUMBER: AD-A239 888

Ji, Shifan. “Development of Tactical Air Defense Laser Weapons at Home and Abroad: An Outline.” Wright-Patterson AFB, OH: National Air Intelligence Center, May 1996. 18p. Translation of **Zhongguo Hangtian** (Aerospace China) (Chinese), 1991, n.164, p. 35-38, 42.

Abstract: This article describes tactical missile defense as an important task of modern air defense and tactical air defense laser weapons as effective weapons. It also describes the history and present condition of laser weapons developed by the three branches of the U.S. Armed

Forces and briefs the research and development of laser weapons in the Soviet Union, Germany, France and the People's Republic of China.

REPORT NUMBER: NAIC-ID (RS) T-0259-96
ACCESSION NUMBER: AD-A310 542

Jones, Y.D., R.P. Copeland, and M.A. Parman. "Xenon Mixing in a Cesium-Free Dudnikov-Type Hydrogen Ion Source." In: Microwave and Particle Beam Sources and Directed Energy Concepts; Proceedings of the Meeting, Los Angeles, CA, January 16-20, 1989. Bellingham, WA: Society of Photo-Optical Instrumentation Engineers, 1989, p. 573-577.

Abstract: the operation of a Dudnikov (1975)-type H(-) ion source using lanthanum hexaboride as the cathode material has been achieved and has been previously reported. The cesium-free operation achieved by using this thermionic emitter is of benefit to the overall neutral particle beam system performance. The source requirement for a neutral particle beam will require higher output from this source. The experimental apparatus is a Penning-type discharge ion source with a variable magnetic field. A brief discussion of the parametric optimization will be covered. In an effort to further increase performance of the Dudnikov source, xenon and argon have been added to the hydrogen fuel used in the source. The inert gas has been added in small amounts (0.2-2.0 percent) as the H(-) and e(-) levels were monitored. Apparatus, diagnostics and results will be discussed.

Junshi Wenzhai (Military Digest) (Selected Articles). Wright-Patterson AFB, OH: National Air Intelligence Center, June 1996. 10p. Translation of **Military Digest** (Chinese), 1995, v. 3, n. 5, p. 1, 25, 53.

Abstract: Contents: Controversy Over Laser Weapons; and Nonlethal Weapons will soon Enter Service.

REPORT NUMBER: NAIC-ID (RS) T-0287-96
ACCESSION NUMBER: AD-A310 532

Kadiramangalam, M.N., M.I. Hoffert and G. Miller. "Onboard Energy Conversion and Thermal Analysis of the MTL System." In: Microwave and Particle Beam Sources and Directed Energy Concepts; Proceedings of the Meeting, Los Angeles, CA, January 16-20, 1989. Bellingham, WA: Society of Photo-Optical Instrumentation Engineers, 1989, p. 313-341.

Abstract: The 'Microwaves-To-Leo' (MTL) energy-transmission concept has been proposed to supply SDI weapons platforms with the requisite power for 'housekeeping', 'alert', and 'burst power' operational modes. An account is presently given of an MTL system's design, component integration and analysis; the parametric design of the MTL-bus subsystems, encompassing among other the rectenna and monolithic solid-oxide fuel cell, is presented and combined with a computer simulation to serve as input in the construction of a comprehensive system-design code. The competitiveness of the MTL design is demonstrated through mass and power comparisons with the SP-100 liquid metal-cooled reactor/Si-Ge thermoelectric generator power system.

Kalman, Gabor J. and T. Li. "Neutral Beam Propagation Through the Atmosphere." Final Technical Report. 1 June 1984 – 1 June 1987. Chestnut Hill, MA: Boston College, Dept of Physics, 15 June 1987. 41p.

Abstract: The problem of Beam Induced Stripping (BIS) process, occurring when a neutral beam propagates through the Earth's atmosphere, has been analyzed. At high current densities

the process is important and leads to a rapid disintegration of the beam. At lower current densities currently contemplated for experiments, the effect is probably not significant.

REPORT NUMBER: AFGL-TR-87-267
ACCESSION NUMBER: AD-A188 984

Kaplan, Leonard, Gon-Yen Shen, and Bruce Maccabee. “Wide Field Integrated Beam Control Demonstration Status (Advanced Beam Control System Program).” In: Controls for Optical Systems; Proceedings of the Meeting, Orlando, FL, April 21-22, 1992, p. 209-220.

Abstract: An integrated beam control demonstration (IBCD) is being fabricated and tested under the direction of the Naval Surface Warfare Center for the SDIO. The IBCD demonstrates the key technologies required for implementing a three-mirror, wide field of view (WFOV), Advanced Beam Control system for a space-based laser. This paper describes an overview of the IBCD and progress in the fabrication and testing of the WFOV beam expander, the outgoing wavefront sensor, the deformable mirror, the dynamic steering mirrors, the wavefront control subsystem, and the high speed diagnostic interferometer. The results include photos of the IBCD and hardware assemblies and evaluation of wavefront control performance.

Keller, W.E. “Physics Division (Los Alamos National Laboratory) Progress Report, January 1, 1984-September 30, 1986.” Los Alamos National Laboratory, NM. October 1987. 205p.

Abstract: This report provides brief accounts of significant progress in development activities and research results achieved by Physics Division personnel during the period January 1, 1984, through September 31, 1986. These efforts are representative of the three main areas of experimental research and development in which the Physics Division serves Los Alamos National Laboratory's and the Nation's needs in defense and basic sciences: (1) defense physics, including the development of diagnostic methods for weapons tests, weapon-related high-energy-density physics, and programs supporting the Strategic Defense Initiative; (2) laser physics and applications, especially to high-density plasmas; and (3) fundamental research in nuclear and particle physics, condensed-matter physics, and biophysics. Throughout the report, emphasis is placed on the design, construction, and application of a variety of advanced, often unique, instruments and instrument systems that maintain the Division's position at the leading edge of research and development in the specific fields germane to its mission. A sampling of experimental systems of particular interest would include the relativistic electron-beam accelerator and its applications to high-energy-density plasmas; pulsed-power facilities; directed energy weapon devices such as free-electron lasers and neutral-particle-beam accelerators; high-intensity ultraviolet and x-ray beam lines at the National Synchrotron Light Source (at Brookhaven National Laboratory); the Aurora KrF ultraviolet laser system for projected use as an inertial fusion driver; antiproton physics facility at CERN; and several beam developments at the Los Alamos Meson Physics Facility for studying nuclear, condensed-matter, and biological physics, highlighted by progress in establishing the Los Alamos Neutron Scattering Center.

REPORT NUMBER: LA-11124-PR
ACCESSION NUMBER: DE-88-002998

Kerns, Q.A. and H.W. Miller. “High-Power Radio-Frequency Attenuation Device.” Patent Application. Washington, DC: Department of Energy, Filed 30 December 1981. 25p.

Abstract: A resistor device for attenuating radio frequency power includes a radio frequency conductor connected to a series of fins formed of high relative magnetic permeability material. The fins are dimensional to accommodate the skin depth of the current conduction there through, as well as an inner heat conducting portion where current does not travel. Thermal connections for air or water cooling are

provided for the inner heat conducting portions of each fin. Also disclosed is a resistor device to selectively alternate unwanted radio frequency energy in a resonant cavity.
PAT-APPL-6335996

Kerr, Donald M. "Implications of Anti-Satellite Weapons for ABM Issues." In: SIPRI Symposium on "Outer Space: Can Militarization be Checked," Stockholm, September 21-23, 1983.
Abstract:
LA-UR-83-2455

King, R.J. et al. "Phenomenology of Microwave Coupling. Part I." Livermore, CA: Lawrence Livermore National Laboratory, November 1984. 91p.
Abstract: Recent advances in the development of high power microwave sources have increased the potential for future deployment of microwave weapons. A key ingredient in being able to predict the vulnerability of military systems to such threats involves understanding the phenomenology of how electromagnetic energy couples into cavity-like objects, or the so-called back-door coupling. A similar but much longer standing problem is that of nuclear electromagnetic pulses (EMP) in which the frequencies extend up to several hundreds of MHz. However, compared to EMP coupling, microwave coupling (from 1 GHz to above 40 GHz) is distinctively different because the wavelength is comparable to the size of the ports of entry (apertures, seams, cracks, protruding connectors, etc.). These ports of entry and the interior configuration of a vulnerable system are no longer below cutoff, and can permit significant penetration of the microwave energy into susceptible electronic systems. In fact, these coupling paths can be highly resonant at certain microwave frequencies, making the shielding against microwave threats difficult. This report summarizes the initial efforts at Lawrence Livermore National Laboratory to study the phenomenology of back door coupling at the low microwave frequencies (up to 2.5 GHz). These studies were limited to 2.5 GHz because the limitations of the Electromagnetic Transient Range Facility.
REPORT NUMBER: UCID-20215
ACCESSION NUMBER: DE-85-003097

Kopp, Carlo. "The Electromagnetic Bomb – A Weapon of Electrical Mass Destruction." Clayton, Australia: Monash University, October 1996. 31 p.
Abstract: High Power Electromagnetic Pulse generation techniques and High Power Microwave technology have matured to the point where practical E-bombs (Electromagnetic bombs) are becoming technically feasible, with new applications in both Strategic and Tactical Information Warfare. The development of conventional E-bomb devices allows their use in non-nuclear confrontations. This paper discusses aspects of the technology base, weapon delivery techniques and proposes a doctrinal foundation for the use of such devices in warhead and bomb applications.
ACCESSION NUMBER: AD-A332 511

Krall, J. and Y.Y. Lau. "Modulation of an Intense Beam by an External Microwave Source - Theory and Simulation." Interim report. Washington, DC: Naval Research Laboratory, 7 October 1987. 17p.
Abstract: A time dependent, fully electromagnetic particle code is used to simulate the current modulation in an intense relativistic electron beam (IREB) by an external rf source. It is shown that the intense beam may serve as a power amplifier with good phase stability, as suggested in earlier experiments. Increase in beam bunching by the DC space charge is demonstrated with a simple analytical model.
ACCESSION NUMBER: AD-A185 683

"Laser Technology (Selected Articles)." **Translation of Jiguang Jishu** (Laser Technology) (China), v. 12, no. 3, p. 20-30, 32-36. June 1988. Wright Patterson Air Force Base, OH: National Air Intelligence Center, April 9, 1996.

Abstract: This paper presents high-energy CW HF/DF chemical lasers developed under the U.S. Navy Sealite program and the Alpha program of the DARPA Triad program, and a brief account of Soviet chemical lasers. Continuous wave HF/DF chemical lasers were developed starting in the late sixties as high-power lasers of consistent interest to military circles. These are lasers that have the most matured technology among present-day high-energy lasers. It is hoped that in the near future CW HF/DF chemical lasers can be developed into a space laser weapon to deal with ICBMs. CW HF/DF chemical lasers are an integration of technologies in gas dynamics, chemistry, fluid chemistry, optics, and lasers. By using the branching chain reaction of heat liberation, inversion of the population ratio is generated to obtain lasers.

REPORT NUMBER: NAIC-ID (RS) T-0152-96
ACCESSION NUMBER: AD-A310 409

Lavine, T.L. et al. "High-Power Radio-Frequency Binary Pulse-Compression Experiment at SLAC." Stanford Linear Accelerator Center, CA. May 1991. 13p. In: 1991 Institute of Electrical and Electronics Engineers (IEEE) Particle Accelerator Conference (PAC), San Francisco, CA, 6-9 May 1991.

Abstract: Using rf pulse compression it will be possible to boost the 50- to 100-MW output expected from high-power microwave tubes operating in the 10- to 20-GHz frequency range to the 300- to 1000-MW level required by the next generation of high-gradient linacs for linear colliders. A high-power X-band three-stage binary rf pulse compressor has been implemented and operated at the Stanford Linear Accelerator Center (SLAC). In each of three successive stages, the rf pulse-length is compressed by half, and the peak power is approximately doubled. The experimental results presented here have been obtained at power levels up to 25-MW input (from an X-Band klystron) and up to 120-MW output (compressed to 60 nsec). Peak power gains greater than 5.2 have been measured.

REPORT NUMBER: SLAC/PUB-5451, CONF-9105059-0
ACCESSION NUMBER: DE-91-012395

LeClaire, R.J., Jr. "Beam Profile Effects on NPB Performance." Los Alamos National Laboratory, NM, March 1988. 20p.

Abstract: A comparison of neutral particle beam brightness for various neutral beam profiles indicates that the widely used assumption of a Gaussian profile may be misleading for collisional neutralizers. An analysis of available experimental evidence shows that lower peaks and higher tails, compared to a Gaussian beam profile, are observed out of collisional neutralizers, which implies that peak brightness is over estimated, and for a given NPB platform-to-target range, the beam current (power), dwell time or some combination of such engagement parameters would have to be altered to maintain a fixed dose on target. Based on the present analysis, this factor is nominally about 2.4 but may actually be as low as 1.8 or as high as 8. This is an important consideration in estimating NPB constellation performance in SDI engagement contexts.

REPORT NUMBER: LA-11228-MS
ACCESSION NUMBER: AD-A344 742

Lee, R. et al. "Near Term Kinetic Energy Anti-Satellite Weapon System (KE-ASAT WS) Program. 1991 Electric Gun Tests, Test and Analysis Report: M1 Test Series." Livermore, CA: Lawrence Livermore National Laboratory, May 1992. 35p.

Abstract: The purpose of the electric gun tests was to investigate the effect of the impact of a thin membrane on materials of interest in 6--10 km/s, simulating the impact of a membrane the

velocity range kill device on a satellite target. The impulse delivered to a satellite structure by such a collision must be known in order to design a membrane kill device for an anti-satellite weapon and to design the SELT tests which demonstrate the effect of broad-area impulsive loads on satellite structures. The impulsive load delivered to a structure by a membrane impact may exceed the momentum/area of the membrane because of rebound, blowoff of vaporized membrane material, and ejection of molten and fractured material from the target (impulse gain). It is important to quantify the impulse gain experimentally in the velocity range of interest. Also of interest is physical damage to the target including spall, melting and fracture. The electric gun facilities at LLNL are a unique resource for studying membrane impacts at hypervelocities. Velocitiesas high as 18 km/s have been demonstrated with thin Kapton membranes (flyer plates) of about 1 cm diameter, 0.3-mm-thickness; 6 km/s for 15-cm-square, 0.2-mm-thickness; and 4 km/s for 30.5-cm-square, 0.15-mm-thickness. Experiments are diagnosed with a full complement of diagnostics including electronic streak cameras, Fabry-Perot laser velocimeters, and flash x ray (FXR). Que proved to be the most useful because it was more accurate and did not suffer from edge effects. The impulse gain we measured was consistent with the predictions of simple theories. To understand and confirm the experimental results, one- and three-dimensional hydrodynamic simulations of the experiments were performed. The simulations were particularly useful in understanding the differences between experiments performed using the ballistic and wave-profile techniques.

REPORT NUMBER: UCRL-ID-110801
ACCESSION NUMBER: DE-93-010480

Legro, J.R., N.C. Abi-Samra and F.M. Tesche. “Study to Assess the Effects of Magnetohydrodynamic Electromagnetic Pulse on Electric Power Systems.” Phase 1, Final Report. Volume 3. Pittsburgh, PA: Westinghouse Electric Corp., Advanced Systems Technology Division, May 1985. 135p.

Abstract: In addition to the initial transients designated as fast transient high-altitude EMP (HEMP) and intermediate time EMP, electromagnetic signals are also perceived at times from seconds to hundreds of seconds after a high-altitude nuclear burst. This signal has been defined by the term magnetohydrodynamic-electromagnetic pulse (MHD-EMP). The MHD-EMP phenomena has been both detected in actual weapon tests and predicted from theoretical models. This volume documents a preliminary research effort to investigate the nature and coupling of the MHD-EMP environments to electric power systems, define the construction of approximate system response network models, and document the development of a unified methodology to assess equipment and systematic vulnerability. The MHD-EMP environment is compared to a qualitatively similar natural event, the electromagnetic environment produced by geomagnetic storms.

ACCESSION NUMBER: DE-85-011301

Lemke, R.W. “Linear Stability of Relativistic Space-Charge Flow in a Magnetically Insulated Transmission Line Oscillator.” Final report. 2 January 1986-31 May 1988. Kirtland AFB, NM: Air Force Weapons Laboratory, April 1989. 103p.

Abstract: The magnetically insulated transmission line oscillator (MILO) is a high-power microwave device that combines the technologies of magnetically insulated electron flow and slow wave tubes. This combination makes the MILO a unique and robust device capable of operation over a wide range of voltages. MILOs are linear, two-conductor systems comprised of a cathode and an anode. The cathode is a smooth conductor. The anode consists of periodically spaced cavities. The system forms a slow wave transmission line capable of transmitting electromagnetic waves having phase velocities less than the speed of light (slow waves). MILO operation is initiated by charging the cathode to high voltage with respect to the anode. The large electric field on the cathode surface generates a plasma from which electrons are emitted. For sufficiently high voltage, the electrons are magnetically insulated from the anode and drift down the transmission line with substantial kinetic energy. A microwave generating instability occurs when the slow electromagnetic wave phase velocity is slightly less than the electron drift velocity when wave amplification occurs at the expense of electron energy. The dispersion relation is obtained by applying

linear perturbation theory to Maxwell's equations coupled to equations for the electron equilibrium. Two models are used for the electron equilibrium: (1) thin-beam, and (2) relativistic Brillouin flow. The dispersion relation is numerically solved to obtain oscillation frequencies and growth rates of modes in the MILO.

REPORT NUMBER: AF-WL-TR-88-103
ACCESSION NUMBER: AD-A207 793

Lemke, Raymond W. "Linear Stability of Relativistic Space-Charge Flow in a Magnetically Insulated Transmission Line Oscillator." In: Microwave and Particle Beam Sources and Directed Energy Concepts; Proceedings of the Meeting, Los Angeles, CA, January 16-20, 1989. Bellingham, WA: Society of Photo-Optical Instrumentation Engineers, 1989, p. 112-124.

Abstract: The magnetically insulated transmission line oscillator (MILO) is a high power microwave device that combines the technologies of magnetically insulated electron flow and slow-wave tubes. This combination makes the MILO a unique and robust device capable of operating over a wide range of voltages. Microwaves are generated in the MILO via an unstable interaction between slow electromagnetic modes and space-charge waves. A linear analysis of this microwave instability that includes the physics of magnetically insulated flow is presented. A dispersion relation is derived for TM modes in a cylindrical MILO. The dispersion relation is solved numerically to obtain the MILO frequency spectrum and instability growth rates. The linear theory results are compared with numerical simulation, and excellent agreement is obtained.

"Les Defis Poses Par la Conception des Futurs Systemes EW (Challenge of Future EW System Design)." Advisory Group for Aerospace Research and Development, Neuilly-sur-Seine (France).
cMay 1994. 147p. In English and French. Symposium Held in Ankara, Turkey, 18-21 October. 1993.

Abstract: Electronic warfare (EW) has emerged as a critical driving force in modern warfare. New generations of weapon systems directly impact EW requirements and strategies. Modern combat aircraft are faced with a drastic change of a possible threat scenario consisting of a mix of Western and Eastern weapon systems. The deployment of advanced pulse doppler radar systems in A/A and G/A application augmented by extensive electro-optic capabilities, directed energy weapons (laser or particle beam), and electromagnetic/shockwave weapons requires a detailed reassessment of NATO EW processes. The complexity and diversity of future threat scenarios necessitate changes in NATO EW system concepts, and an update of existing equipment including modifications of tactics and combinations of EW resources to improve survivability.

REPORT NUMBER: AGARD-CP-546
ACCESSION NUMBER: N9514200

Li, Hui. and Zibin Wang. "Development of Foreign High-Powered Microwave Weapons and Prospects of Future Applications in Space-Based Target Defense and Air Defense." National Air Intelligence Center, Wright-Patterson AFB, OH. 8 March 96. 34p. Translation of unidentified *Chinese language report, n.d.*

Abstract: This paper outlines the development of foreign high-power microwave weapons and their technologies and, by introducing high-power microwave sources and effects, analyzes the prospects of their applications in space-based target defense and air defense.

REPORT NUMBER: NAIC-ID (RS) T-0617-95
ACCESSION NUMBER: AD-A306 465

Liska, D. and L. Dauelsberg. "Design of High-Power Radio-Frequency Drive Loops for Operation into 425-MHz Linear Accelerators." Los Alamos National Laboratory, NM. April 1988. 20p.

Abstract: Recent designs for ultra high-frequency (UHF) band accelerators have prompted the need for high-powered drive loops compatible with the peak and average power needs of the accelerator tanks. Two such loops have been developed in the Accelerator Technology (AT) Division at Los Alamos and are now part of the general accelerator inventory. One loop is of small size, appropriate for radio-frequency quadrupole (RFQ) injector-accelerators, and is rated at 500-kW peak, 2-ms pulse length and 5% duty factor. The other loop is a 1-MW design, physically larger, also rated at 2-ms pulse length and 5% duty factor. The 1-MW drive loop uses a flat-disk ceramic window. The 500-kW loop as developed can use either a flat disk window or a special lambda2 window module available from Oak Ridge National Laboratory (ORNL). The purpose of this note is to describe the design of these loops and the tests performed on them so that they might be used by design engineers with appropriate applications.

ACCESSION NUMBER: DE-88-010305

"LMF Laboratory Microfusion Capability Study: Phase 1, Summary." Washington, DC: Department of Energy, Inertial Fusion Division, 1988. 102p.

Abstract: This report discusses the following topics on Laboratory Microfusion capability (LMC); Utility of an LMC; LMC Development Issues; LMC Requirements; Siting, Safety, and Environmental Criteria; Staffing and Management Issues; and Major Cost Factors.

REPORT NUMBER: DOE-DP-0069
ACCESSION NUMBER: DE-89-011326

Longtin, David R. and Michael G. Cheifetz. "Impact of Aerosol Forward Scattering on the ABL System." Scientific Report no.10. Lexington, MA: Sparta Inc., 20 December 1994. 47p.

Abstract: The AirBorne Laser (ABL) theater missile defense system involves the delivery of large amounts of highly focused energy across long, nearly horizontal paths in the upper troposphere and stratosphere. The current study addresses whether high amounts of aerosol forward scattering may impact ABL performance. The current study asserts that aerosol forward scattering effects are minimal for the ABL system and cannot account for the starlight scintillation behavior as measured by aircraft at ABL altitudes. Using appropriate scattering theories and numerical simulation techniques, the analysis considered possible contributions from the single scattering diffraction peak as well as multiple scattering near the optical axis. It was found that the characteristic scattering angles for background stratospheric aerosols and thin cirrus are too large, especially when compared with the transmitter divergence angles of the high energy laser and the tracking microradians to milliradians. Scattering energy is directed well away from the optical axis and, therefore, the energy received near on axis effectively equals the energy transmitted through the atmosphere. On-axis forward scattering effects become important for background stratospheric aerosols and thin cirrus only when scattering optical depths are on the10 or greater.

ACCESSION NUMBER: AD-A301 229

Lynch, M.T. and J.C. Devenport. "Operational Results of the BEAR (Beam Experiments Aboard a Rocket) Flight RF (Radio Frequency) System." Los Alamos National Laboratory, NM. 1989. 14p. In: 13th Particle Accelerator Conference, Chicago, IL, 20 March 1989.

Abstract: The Beam Experiments Aboard a Rocket (BEAR) flight rf control system has been completely designed and has been operated as a part of the flight accelerator system in the actual flight configuration. The accelerator has been vertically integrated onto the flight support structure (space frame) and has been operated in this configuration in preparation for the actual

flight which is scheduled for late Spring, 1989. The rf control system consists of redundant voltage controlled oscillators, redundant amplitude controllers which maintain the proper fields in the RFQ, a frequency controller to maintain operation at the resonant frequency of the RFQ, and the necessary system monitors and interfaces required for the amplifiers, onboard system controller, and telemetry. The rf controller had to meet the electrical and environmental requirements while staying within its weight limit. This paper describes the final design of the rf controller and results from operation of the controller in its final flight configuration.

REPORT NUMBER: LA-UR-89-888, CONF-8903355-0
ACCESSION NUMBER: DE-89-009291

Major, A.L. and A.A. Vivona, Jr. "Space Shuttle Integration Considerations for Nuclear Power System." In: Space Nuclear Power Systems 1984; Proceedings of the First Symposium, Albuquerque, NM, January 11-13, 1984. Volume 1. Malabar, FL: Orbit Book Co., Inc., 1985, p. 87-91.

Abstract: There is renewed national interest in developing nuclear space power generation technology for the 1990s. The program objective calls for a prototype 100 kW unit in space by 1995. One conceptual design envisions a unit of approximately 3000 kg with a 6 meter length and 4 ½ meter diameter. The nuclear subsystem mass (reactor, heat pipes and radiation shield) accounts for approximately 70 percent of the power unit's weight. Airborne Support Equipment (ASE) includes the cargo bay cradles to support the space power system within the Space Transportation System (STS) Orbiter cargo bay. Department of Defense (DOD) potential applications for nuclear space power include directed-energy weapons, electronic jamming, and surveillance operations. The National Aeronautics and Space Administration (NASA) envisions such use in providing electrical power for space stations, lunar operations, and deep planetary explorations. This paper examines some integration issues involved in using the STS and focuses on safety considerations.

Manheimer, Wallace M. "High Power Microwaves for Defense and Accelerator Applications." Memorandum Report 6661. Washington, DC: Naval Research Laboratory, 11 June 1990. 74p.

Abstract: This paper discusses high power microwaves for application to the Defense Department and to the powering of large accelerators. The microwave sources discussed are the SLAC klystron, the relativistic klyston, the magnetron and the vircator.

REPORT NUMBER: NLR-MR-6661
ACCESSION NUMBER: AD-A223 550

Marquet, Louis C. "Directed Energy Program." In: Lasers '85; Proceedings of the Eight International Conference, Las Vegas, NV, December 2-6, 1985. McLean, VA: STS Press, 1986, p. 247-252.

Abstract: The Strategic Defense Initiative Organization's Directed Energy Program is a technology-development effort aimed at the identification and validation of promising candidate systems for boost-phase and postboost-phase interception of ballistic missiles, as well as missile midcourse-phase interactive discrimination of warheads from decoys. Both near-term, first-generation systems and longer term development thrusts are encompassed, for the cases of space-based lasers, ground-based lasers, space-based particle beams, and nuclear directed energy weapons. Attention is presently given to recent significant accomplishments.

Marshall, Albert H. and Ronald S. Wolff. "Semiconductor Laser Weapon Trainer and Target Designator for Live Fire." Patent. Washington, DC: Department of the Navy, Filed 20 May 1991, Patented 16 March 1993. 6p.

Abstract: Disclosed is a capability for training and other uses wherein a firearm can be aligned with its target by use of a laser beam, or the target can be designated to others by illuminating it with the laser beam. A laser diode that provides visible light is used in conjunction with the boresight of a gun to paint a visible spot on an intended target at the location the bullet will impact if the weapon were fired, The beam emitted by the diode is collimated by a miniature gradient refractive index lens co-located with the diode on a heat sink that is included to convey heat away from the heat sensitive components. A circuit having a photodiode and a differencing amplifier is included to provide stability in the output of the laser, in order to overcome the effects of thermal excursions, and to protect the reflective surfaces of the laser from power surges. The on-off switch is a pressure sensitive material removably attached to the gun in a convenient location for it to be operated by the user's gun hand.

PATENT: 5,194,007

Mastroianni, George R. "Qualitative Arms Control: The Case of Laser Weapons." Report for May 1989 – June 1990. Presidio of San Francisco, CA: Letterman Army Institute, 11 September 1990. 16p.

Abstract: One type of arms control agreement limits the possession or use of specific kinds of weapons – such agreements are called qualitative arms control. Placing numerical limits on arsenals is more common qualitative arms control. This paper examines the history of qualitative arms control in the twentieth century, and discusses some theoretical analyses of the conditions necessary for successful arms control negotiations. Laser weapons, which are emerging as a matter of international concern, are discussed in light of the general principles that arise from consideration of the theoretical issues in arms control. Of particular concern are the need for mutual interest in reaching agreement among the parties to arms control negotiations, and the achievement of parity. The achievement of international control of laser weapons is not likely to succeed soon, because the conditions necessary for effective negotiation have been met.

ACCESSION NUMBER: AD-A229 132

Mastroianni, George R. and B. Stuck. "Soldier Awareness of the Threat from Directed Energy." Report for April-October 1989. Presidio of San Francisco, CA: Letterman Army Institute of Research, September 1989. 19p.

Abstract: Ten intelligence specialists responded to a survey concerning basic knowledge of directed energy (DE) weapons, countermeasures, and characteristics. The responses indicated sophisticated understanding of the DE threat in some areas, but significant weakness in others. In particular, understanding of the dimensions and ranges of current lasers was poor, as was knowledge of laser injury symptomatology and first aid procedures. The result suggest specific areas for training development effort in the future.

REPORT NUMBER: LA-IR-88-75
ACCESSION NUMBER: AD-A214 319

Mayhall, D.J. and J.H. Yee. "Low-Frequency Circuit Analysis of MHD-EMP-Induced Transients on Three-Phase Distribution Systems." Livermore, CA: Lawrence Livermore National Laboratory, July 1992. 6p. In: 1993 HEART Conference, Orlando, FL, 1-5 February 1993.

Abstract: The magnetohydrodynamic electromagnetic pulse (MHD-EMP) generated by a nuclear explosion in the earth's ionosphere is believed by a number of researchers to pose a potentially severe threat to long electric utility transmission and distribution systems in the United States. The disturbances caused by MHD-EMP are similar to the electromagnetic transients caused by solar-induced geomagnetic storms, but are generally expected to be more intense with shorter durations. Recent solar-induced storms have caused appreciable damage to electric utility equipment in Canada and the northern United States. In March of 1989, a solar-induced geomagnetic storm caused a blackout of the Hydro-Quebec power system

in the province of Quebec, failure of step-up power transformers at the Salem Nuclear Generating Plant of the Public Service Electric and Gas Company, and a number of less severe power disruptions in the United States. Since the amplitudes of MHD-EMP induced transients are expected to be stronger than those produced by solar-induced geomagnetic storms, unprotected electric utility power systems may be quite vulnerable to MHD-EMP.

REPORT NUMBER: UCRL-JC-111477, CONF-9302120-3
ACCESSION NUMBER: DE-93-016450

McCulloch, W.H. "Estimated Burst Power Requirements for Selected SDI (Strategic Defense Initiative) Missions." Albuquerque, NM: Sandia National Labs., 1986. 22p. In: Symposium on Space Nuclear Power Systems, Albuquerque, NM, 13 January 1986.

Abstract: Power requirements are estimated for several candidate missions proposed for the Strategic Defense Initiative. The missions of interest are those requiring large electric power supply and power conditioning systems for space-based directed energy weapons, including electromagnetic launchers, free-electron lasers, and neutral particle beams. In general, the power requirements are determined by working backward from lethality considerations, using preliminary descriptions of weapons performance and of candidate engagement scenarios.

REPORT NUMBER: SAND-85-1840C, CONF-860102-6
ACCESSION NUMBER: DE-86-005438

McGrath, Steven J. "The Electromagnetic Pulse Environment and Its Influence on Tactical Electric and Communications Equipment." Master's thesis. Monterey, CA: Naval Postgraduate School, March 1992. 95p.

Abstract: The purpose of this thesis is to aid the military communicator in understanding the phenomenon that is known as the electromagnetic pulse (EMP). This thesis includes a brief history and definition of the EMP and a description of the various EMP environments. It also discusses the effects an EMP can have on exposed electronic components and communications equipment. It provides a description of the major approaches that are used to reduce the harmful effects of an EMP. A discussion of the factors considered in a cost benefit analysis is included for the purpose of establishing cost and benefit considerations relevant to a system's evaluation. The thesis concludes that the decision of whether or not to protect electronic and communications equipment from an EMP depends on many factors, including the criticality of the equipment's mission and the cost of EMP hardening compared to the benefits received. It also concludes that the nation should maintain its EMP hardening effort for critical systems.

ACCESSION NUMBER: AD-A246 754

McKenzie-Wilson, R. B. "Neutral Beam Test Facility and Radiation Effects Facility at Brookhaven National Laboratory." Upton, NY: Brookhaven National Laboratory, 1990. 22p. In
In: Conference on the Application of Accelerators in Research and Industry (11th), Denton, TX, 5-8 November 1990.

Abstract: As part of the Strategic Defense Initiative (SDI) Brookhaven National Laboratory (BNL) has constructed a Neutral Beam Test Facility (NBTF) and a Radiation Effects Facility (REF). These two facilities use the surplus capacity of the 200-MeV Linac injector for the Alternating Gradient Synchrotron (AGS). The REF can be used to simulate radiation damage effects in space from both natural and man made radiation sources. The H(sup (minus)) beam energy, current and dimensions can be varied over a wide range leading to a broad field of application. The NBTF has been designed to carry out high precision experiments and contains an absolute reference target system for the on-line calibration of measurements carried out in the experimental hall. The H(sup (minus)) beam energy, current and dimensions can also be varied

over a wide range but with tradeoffs depending on the required accuracy. Both facilities are fully operational and will be described together with details of the associated experimental programs.
REPORT NUMBER: BNL-45225, CONF-9011161-1
ACCESSION NUMBER: DE-91-000899

McPherson, A. and C.K. Rhodes. "High Brightness X-Ray Source for Directed Energy and Holographic Imaging Applications." Final report on Phase 2. Chicago, IL: MCR Technology Corp., 31 March 1992. 169p.

Abstract: Advances in x-ray imaging technology and x-ray sources are such that a new technology can be brought to commercialization enabling the three-dimensional (3- D) microvisualization of hydrated biological specimens. The Company is engaged in a program whose main goal is the development of a new technology for direct three dimensional (3-D) x-ray holographic imaging. It is believed that this technology will have a wide range of important applications in the defense, medical, and scientific sectors. For example, in the medical area, it is expected that biomedical science will constitute a very active and substantial market. The basis of this view, is represented directly below. The application of physical technologies for the direct visualization of biological entities has had a long and extremely fruitful history. The invention of the light microscope in the 17th century and the development of the electron microscope shortly before World War II, have obviously been enormously successful scientifically. Equally significantly, these two landmark advances, in addition to revealing radically new physical features of the human environment, have also had a profound and unexpected influence on man's spiritual perception of his world. The light microscope opened up an unseen universe, not only of strange plant and animal life, but also one embodying new shapes and forms, serving to challenge and stimulate the mind. The electron microscope, by greatly enhancing the spatial resolution achievable, led to further seminal findings, such as the first views of viral particles and the complex cytoskeletal structure of cells.
ACCESSION NUMBER: AD-A248 858

Mensing, R.W. "Probabilistic Method for Estimating System Susceptibility to HPM." Livermore, CA: Lawrence Livermore National Laboratory, 18 May 1989. 14p.

Abstract: Interruption of the operation of electronic systems by HPM is a stochastic process. Thus, a realistic estimate of system susceptibility to HPM is best expressed in terms of the probability the HPM have an effect on the system (probability of effect). To estimate susceptibility of complex electronic systems by extensive testing is not practical. Thus, it is necessary to consider alternative approaches. One approach is to combine information from extensive low level testing and computer modeling with limited high level field test data. A method for estimating system susceptibility based on a pretest analysis of low level test and computer model data combined with a post test analysis after high level testing is described in this paper.
REPORT NUMBER UCID-21731
ACCESSION NUMBER: DE-89-014307

Mensing, R.W., R.J. King and H.S. Cabayan. "Method for Estimating the Susceptibility of Electronic Systems to HPM (High Power Microwave)." Livermore, CA: Lawrence Livermore National Laboratory, May 1988. 69p.

Abstract: In this report, a method for estimating the susceptibility of electronic systems to High Power Microwave (HPM) is advanced. This method is being incorporated into an overall DOD assessment methodology that is being prepared by a tri-service working group headed by the Air Force. In the next two years, the methodology will be applied to assess several military systems and modified as necessary to establish a nationally-approved standard methodology. The objective of the effort is to establish a standardized assessment methodology to guide all ongoing US HPM system effects assessment activities. The work will involve development of a detailed, integrated assessment plan that includes system functional

analyses (i.e., system analyses and including all analytical modeling of HPM coupling and subsystem/component susceptibility), low power characterization test, (i.e., coupling/subsystem component tests and system functional response tests), HPM effects tests, and post-test analyses combining system functional analyses, low power characterization test, and methods for extrapolating test results to possible threat parameter regimes not readily simulated.

REPORT NUMBER: UCID-21430
ACCESSION NUMBER: DE-88-012246

Merritt, Paul H. et al. "Active Tracking of a Ballistic Missile in the Boost Phase." Kirkland AFB, NM: Air Force Phillips Laboratory, 1996. In: The International Society for Optical Engineering Acquisition, Tracking, and Pointing X, 1996, Orlando, FL, April 10-11, 1996. Bellingham, WA: SPIE – the International Society of Optical Engineering (SPIE Proceedings, vol. 2739), 1995, p. 19-29.

Abstract: Active tracking of a ballistic missile during the boost phase is a very challenging problem. The airborne laser (ABL) is one of several directed energy weapon programs that is interested in active track since the ABL design may use this technique. The Phillips Laboratory in response to this technical challenge has embarked on a project to verify the feasibility of active tracking over a long horizontal path through the atmosphere. The project is composed of two independent phases. The first phase is investigating tracking through a turbulent atmosphere using a scaled range with a static target at Lincoln Laboratory. The second phase of the project will demonstrate active tracking of boosting theater ballistics missiles using the SeaLite Beam Director at the High Energy Laser system Test Facility at White Sands Missile Range. This paper will present some of the tracking data and review the progress of the tests at both sites.

Messier, M.A. "Peaceful Nuclear Explosion (PNE) Monitoring Techniques." Final report. 23 May 1977-31 July 1979. Santa Barbara, CA: Mission Research Corp., June 1979. 103p.

Abstract: This report presents the results of a preliminary study of techniques, which will aid in reducing the ability of a signatory of a peaceful nuclear explosion (PNE) treaty to use a PNE for illegal purposes, e.g., the testing of nuclear weapons or testing the vulnerability of military systems to nuclear weapons effects. The scope of the study includes investigation of both technical means and appropriate treaty provisions. Ideally, a combination of monitoring techniques, e.g., seismic, EMP, and infrared would be combined with selected treaty provisions to provide maximum assurance that covert testing was not being conducted. Theoretical studies involve the development of individual technologies as well as the most effective methods for combining them. In this effort, emphasis has been placed on investigating the feasibility of an electromagnetic pulse (EMP) monitoring system. Such a system may be useful, when used in conjunction with a seismic system, for detecting explosions hidden among one or more declared peaceful explosions.

ACCESSION NUMBER: AD-A148 561

Miklasevich, James. "A Parametric Analysis of HELSTAR." Master's thesis. Wright-Patterson, AFB, OH: Air Force Institute of Technology, 1983. 96p.

Abstract: The HELSTAR program is analyzed with a view towards verification and validation. The program is divided into three major areas for parametric study: battle management, laser system and battle scenario. The effects of atmospheric attenuation of laser energy, total number of attacking missiles, type of satellite orbit, and time-dependent launches on total system effectiveness are analyzed. In the course of the study the effect of constellation altitude was found to have a significant effect on the size of the final 'optimum' constellation. Since this altitude is determined by the program during initialization and cannot be controlled by the user, it can be considered a limitation of the program. Also, during the investigation of time-dependent launches, an error was found that led to invalid results. The exact location of this report could not be

determined. Aside from the above mentioned limitations, the program was found to generate logical results. It was felt that potential users could use the program with a high degree of confidence that the engagements between ICBM's and space-based lasers were being modeled correctly.

REPORT NUMBER: AFIT/GSO/OS/83D-7
ACCESSION NUMBER: AD-A141 143

"Militarily Critical Technologies List." Volume 1. List of Militarily Critical Technologies. Washington, DC: Office of the Under Secretary of Defense (Acquisition), October 1989. 365p.

Abstract: The FY 1989 MCTL is published in three volumes. The three volumes together outline those items which the Department of Defense considers militarily critical and furnishes detailed descriptions and rationales for inclusion of the items on the MCTL. Volume I, contains the list of militarily critical technologies required by the Export Administration Act of 1979, as well as particulars of all the critical elements. Topics include: Information systems and networks technology; Computer hardware technology; Computer software technology; Automated control of industrial systems (ACIS) technology; Materials and production technology; Directed Energy and Kinetic Energy systems technology; Semiconductor and electronic component technology; Instrumentation technology; Telecommunications technology; Communication, navigation, guidance, control and identification technology; Microwave millimeter wave technology; Optical technology; Sensor technology; Sea surface and undersea systems technology; Chemicals and biotechnology; Nuclear related technology; Survivability and hardening technology; Energy systems technology; Energetic materials and devices technology.

ACCESSION NUMBER: AD-A221 602

"Missiles et Fleches Electromagnetiques (Electromagnetic Missiles and Darts)." Final report.
Societe d'Etudes et Conseils Aero, Paris (France). April 1994. 30p. Text in French; summary in English. Sponsored by Direction des Recherches, Etudes et Techniques, Paris (France). Centre de Documentation de l'Armement.

Abstract: This study addresses the question of whether the high-powered microwave type directed-energy weapon is a promising concept or a mathematical construction that will inevitably be destroyed by physical and technological constraints. The report devotes a section to the problems of source and receiver and the electromagnetic dart concept, one section to the study of the properties of an electromagnetic field radiated by a system of finite extensions, and another section to the coupling of the field with antennas at transmission and at reception. The study leads to the second of the above conclusions. The list of bibliographical references is extensive.

REPORT NUMBER: AERO-23594-NC

Montanarelli, Nick and Ted Lynch. "Applications of the Strategic Defense Initiative's Compact Accelerators." Washington, DC: Strategic Defense Initiative Organization, Office of Technology Applications. December 1991. 9p. In: NASA, Washington, Technology 2001: The Second National Technology Transfer Conference and Exposition, Volume 2, p. 503-511. [N92-22676]

Abstract: The Strategic Defense Initiative's (SDI) investment in particle accelerator technology for its directed energy weapons program has produced breakthroughs in the size and power of new accelerators. These accelerators, in turn, have produced spinoffs in several areas: the radio frequency quadrupole linear accelerator (RFQ linac) was recently incorporated into the design of a cancer therapy unit at the Loma Linda University Medical Center, an SDI-sponsored compact induction linear accelerator may replace Cobalt-60 radiation and hazardous ethylene-oxide as a method for sterilizing medical products, and other SDIO-funded accelerators may be used to

produce the radioactive isotopes oxygen-15, nitrogen-13, carbon-11, and fluorine-18 for positron emission tomography (PET). Other applications of these accelerators include bomb detection, non-destructive inspection, decomposing toxic substances in contaminated ground water, and eliminating nuclear waste.

ACCESSION NUMBER: AD-A339 072

Moore, H.L., Jr. and R.J. Shippell, Jr. "Directed Energy Technologies: Weaponization and Barrier Applications." US Army ARDEC, Picatinny Arsenal, NJ. In: IEEE Annual International Carnahan Conference on Security Technology, Proceedings. Proceedings of the 1996 30th IEEE Annual International Carnahan Conference on Security Technology, October 2-4, 1996. p. 220-225.

Abstract: The military is coordinating with other government agencies to develop Directed Energy Technologies which can be used as nonconventional incapacitation weapons. The focus of the research is the use of either acoustic energy or the combination of acoustic energy and flashing white light to protect the citizenry against crime and other threats to civil liberty while reducing collateral damage.

Moose, William J. "A Proportional-Plus-Integral Controller for a Particle Beam Weapon." Master's thesis. Wright-Patterson, AFB, OH: Air Force Institute of Technology, 1984. 98p.

Abstract: The goal of this thesis is to design a proportional-plus-integral (PI) controller, for use with the Meer filter, to control a particle beam weapon. The device used to measure the beam produces a low signal rate, the Meer filter is used to produce and estimate of the beam position. Atype-1, proportional-plus-integral controller is designed using LQG assumptions and dynamic programming to solve the cost function. A sensitivity analysis is performed to determine the system sensitivity to different parameters. A performance analysis is also performed to demonstrate the system robustness to unmodeled errors. The results of these analyses are compared to a type-O, proportional gain controller. In addition the PI controllers ability to regulate to non-zero setpoint is demonstrated.

REPORT NUMBER: AFIT/GA/ENG/84D-3
ACCESSION NUMBER: AD-A153 213

Morgan, K.D. et al. "Conventional Armament Technology Area Plan, FY96." Eglin AFB, FL: Wright Laboratory, July 1995. 35 p.

Abstract: The FY96 Conventional Armament Technology Plan (TAP) is used to explain and outline the technologies and programs the Wright Laboratory Armament Directorate, Eglin AFB, FL performs. It is reviewed by the Air Force Science and Technology community to inform and to report Air Force activities throughout the Air Force Laboratories. The TAP provides the reader with the Armament Directorate's Vision, basic funding, and major accomplishment of the major technology thrust areas at the Armament Directorate. These thrusts are (a) the Advanced Guidance Thrust, (b) the Ordnance Thrust, and (c) the Instrumentation Thrust. The Conventional Armament TAP is one of several technology plans that supports Wright Laboratory, Wright-Patterson AFB, OH.

REPORT NUMBER: WL-TR-96-7000
ACCESSION NUMBER: AD-A299 085 [also available via DTIC's Fulltext Technical Reports Internet Site]

Muller, Clifford H. "Department of Defense High Power Laser Program Guidance." Final report. Kirtland AFB, NM: Phillips Laboratory, 6 June 1994. 23p.

Abstract: The DoD investment of nominally $200 million per year is focused on four high power laser (HPL) concepts: Space-Based Laser (SBL), a Ballistic Missile Defense Organization effort that addresses boost-phase intercept for Theater Missile Defense and National Missile Defense, Airborne Laser (ABL), an Air Force effort that addresses boost-phase intercept for Theater Missile Defense, Ground-Based Laser (GBL), an Air Force effort addressing space control, and Anti-Ship Missile Defense (ASMD), a Navy effort addressing ship-based defense. Each organization is also supporting technology development with the goal of achieving less expensive, brighter, and lighter high power laser systems. These activities represent the building blocks of the DoD program to exploit the compelling characteristics of the high power laser. Even though DoD's HPL program are focused and moderately strong, additional emphasis in a few technical areas could help reduce risk in these programs. In addition, a number of options are available for continuing to use the High-Energy Laser System Test Facility (HELSTF) at White Sands Missile Range. This report provides a brief overview and guidance for the five efforts which comprise the DoD HPL program (SBL, ABL, GBL, ASMD, HELSTF).

ACCESSION NUMBER: AD-A282 915

Nakai, John H. and Mark S. McCray. "Strategic Defense Initiative Mass Properties Challenges." In SAWE, 45th Annual Conference, Williamsburg, VA, May 12-14, 1986. 15p.

Abstract: An overview is presented of the terminology and technical challenges associated with the Strategic Defense Initiative (SDI), considering also specific impacts of SDI on mass properties engineering. The overall objective of SDI is to create technology options and concepts for a multitiered defense system against either land- or sea-based energy ICBMs. Directed energy weapons include space-based chemical lasers (such as hydrogen, fluoride and deuterium fluoride), ground-based lasers with space-based mirrors, X-ray lasers, space-based neutral particle beams, electron beams, microwave generators, and others. Kinetic energy weapons include rockets, electromagnetic guns and hypervelocity guns. Mass properties analysis is very important because feasibility of the entire defense concept depends on the development of a workable system which competes economically against offensive countermeasures, and system mass is one of the strongest drivers of system cost. Topics covered include: predesign tasks, computer modeling, the ASTRA (Advanced Synthesis and Technical Requirements Analysis program).

REPORT NUMBER: SAWE Paper 1701

Namkung, W., J.Y. Choe and H.S. Uhm. "Research Program on a Compact and High-Power Microwave Tube." Final report. Silver Spring, MD: Naval Surface Weapons Center, February 1986. 42p.

Abstract: A research program on a compact and high-power microwave tube has been initiated for applications to microwave weapons. The proposed microwave tube is a phase-controlled amplifier based on the newly developed cusptron microwave tube concept. The objective of this program is to develop a cusptron amplifier of 5-9 GHz, 80-100 MW, 10 microsec pulse length, and 1-10 kHZ repetition rate. The immediate goal is the construction of a medium power tube of 5-9 GHz, 200-250 KW, 10 microsec pulse length, and 1 KHz repetition rate. The program covers a three year period, CY 86-88. Contents: Description of Proposed Research; Costs and Schedule; Appendices (Reprints): Observation of Microwave Generation from a Cusptron Device; Linear Theory of Cusptron Microwave Tubes; Experimental Results - Cusptron Microwave Tube Study; Design Study of Cusptron Amplifier for Accelerators.

ACCESSION NUMBER: AD-A171 567

"NCS EMP (National Communications System Electromagnetic Pulse) Mitigation Program: Aerial TI System Test Plan." Final report. Bethesda, MD: Booz-Allen and Hamilton, Inc., August 1986. 32p.

Abstract: This program mitigates the damaging effects of nuclear weapons on regional and national telecommunications capabilities. To meet this objective, the OMNCS has sponsored efforts to create a network level model to assess the effects of High-Altitude EMP (HEMP). In addition, the OMNCS has sponsored efforts to collect the level HEMP effects to data required to support the network-level model. The products of this model will assist the NCS in identifying potential vulnerabilities of national telecommunications capabilities to HEMP and to support National Security & Emergency Preparedness (NSEP) initiatives.

ACCESSION NUMBER: AD-A173 520

"Network Level Fallout Radiation Effects Assessment." Final report. Bethesda, MD: Booz-Allen and Hamilton, Inc., May 1991. 34p.

Abstract: National Security calls for the ability to maintain communication capabilities in times of national disaster, which could include a nuclear attack. Nuclear detonation has two basic by-products for which telecommunication equipments are susceptible to damage. These are electromagnetic pulse (EMP) and fallout radiation. The purposes of the EMP Mitigation Program are to analyze and to lessen the effects of EMP and fallout radiation on national telecommunications resources. Fallout radiation occurs after the initial intense high-frequency EMP, and is the subject of this analysis. Fallout radiation is the residual radiation that remains in the atmosphere after a nuclear blast, and which can be carried by weather conditions to locations far from the detonation point. This analysis focuses on the effects of fallout radiation on the telecommunications network of the American Telephone and Telegraph Co. (AT and T). This assessment of AT and T-network's communications-capabilities uses a network-level approach to assess fallout-radiation effects on the network's performance. The approach used was developed for assessing network-level EMP effects on Public Switched Network communication capabilities. Details are given on how EMP assessments utilize this method. Equipment-level fallout-radiation survivability data is also required.

ACCESSION NUMBER: AD-A245 924

Ng, L.C., M.A. Summers, and V.P. Brugman. "Guidance and Control Experiments at the Nevada Test Site." Livermore, CA: Lawrence Livermore National Laboratory, 26 August 1996. 15p. In: Annual AIAA/BMDO Technology Readiness Conference (5th), Ft. Walton Beach, FL, 16-20 September 1996.

Abstract: Kinetic kill vehicle intercept experiments were conducted at the Nevada Test Site to evaluate a vehicle's intercept performance under a realistic, zero g environment. Intercept experiments successfully identified potential hardware and software deficiencies under divert guidance tests; validated the 6 degrees of freedom (DOF) simulation model; and achieved a submeter intercept in 15 intercept attempts.

REPORT NUMBER: UCRL-JC-125060, CONF-9609248-1
ACCESSION NUMBER: DE-96-050418

Nguyen, Richard T. "Simulations of LANL Regenerative MW Free Electron Laser Amplifier." Master's thesis. Monterey, CA: Naval Postgraduate School, December 1997. 54p.

Abstract: The development of a speed-of-light hard-kill weapon system for military applications represents a significant advancement in technology over present conventional kinetic weapon systems. Over the past two decades, the US Navy has successfully developed a megawatt-class chemical laser; however, under some maritime environments, the high power beam propagation was unable to delivery sufficient energy to kill a modern anti-ship missile (ASM) due to significant atmospheric absorption and the resulting thermal blooming process. A critical problem to resolve for the shipboard high-energy laser weapon systems is to develop a shipboard-compatible megawatt-class laser weapon at a wavelength where the atmospheric absorption is smallest. The megawatt-class Free Electron Laser (EEL) has significant advantages over conventional weapon

systems and other chemical high-energy laser systems. Infinite magazine, rapid response, and wavelength tunability make the EEL a suitable and desirable shipboard weapon system. This thesis divides into four chapters. Chapters I and II introduce the EEL and background theory of the EEL. Chapter III explores the analysis of the LANL Regenerative MW EEL Amplifier design and optimizes its efficiency. Lastly, chapter IV summarizes the feasibility of achieving the desired efficiency.

ACCESSION NUMBER: AD-A342 -24

North Atlantic Treaty Organization. "Defence Research Group. Panel 1 on Long-Term Scientific Studies, Technical Proceedings of the Joint DRG/AGARD Symposium on High Power Microwaves." Brussels, Belgium: North Atlantic Treaty Organization, 31 May 1995. 280p.

Abstract: *This publication (also published as AGARD-CP-564) contains the unclassified papers presented to a specialists' meeting sponsored jointly by the AGARD Sensor and Propagation Panel and Defence Research group (DRG) of NATO. The topics covered on the occasion of that meeting on the subject of "high Power Microwaves (HPM)" included: -High Peak Power Generators – Transmission Line and Antenna Peak Power Handling – Atmospheric Microwave Breakdown – Target Coupling Mechanisms-Components and Subsystems Vulnerability-Hardening Against HPM-Test Facilities.*

ACCESSION NUMBER: AD-A295 112

"NRL Review for 1993." Washington, DC: Naval Research Laboratory, 1993. 286p.

Abstract: *Featured Research at NRL: Opioid Peptides-X-ray Characterization of Two Potent Enkephalin Analogs; Ultrathin Magnetic Film Research at NRL; Communicating with Chaos; Trans Oceanic Acoustic Propagation and Global Warming; Acoustics: Electroacoustic Transducer Transient Suppression: BiKR-A Range-Dependent, Normal-Mode Reverberation Model for Bistatic Geometries; Predicting Acoustic Signal Distortion in Shallow Water; Chemical/Biochemical research: Development of Polyurethane/Epoxy Based Interpenetrating Polymer Networks for Damping Applications; Ultrafast Photochemical Processes; Chemical Adhesion Across Composite Interfaces; Nanocapillarity in Fullerine Tubules; and Neuronal Patterning.*

REPORT NUMBER: NRL/PU/5230-92-235
ACCESSION NUMBER: AD-A265 666

Nunz, G.J. "Beam Experiments Aboard a Rocket (BEAR) Project." Final report. Volume 1, Project summary. Progress report. Los Alamos National Laboratory, NM. January 1990. 103p.

Abstract: *The US Department of Defense's Strategic Defense Initiative Organization is sponsoring the development of neutral particle beam (NPB) technology for strategic defense applications. The first step in demonstrating the functioning of an NPB in space was the development and launch of the Beam Experiments Aboard a Rocket (BEAR) in New Mexico in July 1989. A government, laboratory, and industrial team, under the technical coordination of Los Alamos National Laboratory, designed, developed, and tested the BEAR payload. The primary objective of BEAR was the operation of an NPB accelerator in space. The payload was also designed to study (1) the effects on the space vehicle of emitting an NPB and associated charged beams into the space environment; (2) the propagation and attenuation characteristics of an NPB in space; (3) the dynamics of the charged particle components of the beam in the geomagnetic field; (4) the effects of neutral effluents from the vehicle; and (5) any anomalous or unanticipated*

phenomena associated with operating an NPB in the space environment. The BEAR experiment successfully demonstrated operation of an NPB accelerator and propagation of the neutral beam as predicted in space, obtained first-of-a-kind NPB physics data, and demonstrated the ability of the BEAR accelerator to survive recovery and to continue operating normally. No unanticipated phenomena were encountered that would significantly delay further development of NPB technology for defensive, space-based weapon systems.

REPORT NUMBER: LA-11737-MS-Vol 1
ACCESSION NUMBER: DE-92-018091/AD-A338 597

Okolie, C.C. “Legal Requirements for the World’s Protection of Outer Space and Earth Environments Within the Perspective of Directed Energy Weapons.” In: Colloquium on the Law of Outer Space, 25th, Paris, France, September 27 – October 2, 1982. New York, NY: American Institute of Aeronautics and Astronautics, 1983, p. 25-35.

Abstract: *Space law considerations of directed energy weapons are discussed. The possibility of such weapons being deployed is examined in terms of international treaties and the capabilities of the superpowers and their ongoing programs in the area. A new international treaty to be submitted to the United Nations is proposed for the protection of the earth and outer space environments and for banning the development and testing of directed energy weapons in outer space. Loopholes in existing treaties are identified. The role of the third world in promoting reciprocity between the U.S. and the U.S.S.R. is addressed. A U.S. case law which may be applicable to the issue is discussed.*

REPORT NUMBER: IAF Paper 82-IISL-08

“Opto-Mechanical Design and Fabrication Services.” Final report. Progress Report. Los Alamos, NM: Optomec Design Co., Los Alamos National Laboratory, NM, 28 February 1988. 7p.

Abstract: *Each of the seven tasks defined under this contract are discussed here. They include: (1) design support for an x-ray spectrometer for the "Panchuela" down-hole experiment at the Nevada Test Site; (2) development and demonstration of an optical alignment method for aligning the 180 degree bend achromatic magnetic section of the Ground Test Accelerator; (3) development of magnet support and manipulation concepts for the 17 magnets of the Ground Test Accelerator; (4) design support for the triplett magnet telescope assembly and its support structure (Neutral Particle Beam Program); (5) design and support for the beam diagnostic system for the Argonne Particle Beam experiment; (6) conceptual design for the modification of an Antares Marx tank for use in the Aurora Laser Program; and (7) design of poloidal gap for the Los Alamos ZTH reversed-field pinch machine.*

REPORT NUMBER: LA-SUB-93-143
ACCESSION NUMBER: DE-96-000173

“Opto-Mechanical Support Services.” Final report. Progress Report. Los Alamos, NM: Optomec Design Co., Los Alamos National Laboratory, NM, 11 June 1990. 3p.

Abstract: *This subcontract was for Optomec'c support of the Los Alamos National Laboratory's (LANL's) Group MEE-12 in the technical specialty area of opto-mechanical design, engineering and fabrication. Two individual tasks were defined by MEE-12 and completed by Optomec personnel. Edward J. Yavornik acted as Principal Investigator on the Wire and Fluorescent Fiber Offset Grid (WAFFOG) for the Neutral Particle Beam (NPB) GTA (Ground Test Accelerator) Experiment, and Thomas Swann acted as Principal Investigator on the ESS-7 Photometers Project. Some hardware was procured/fabricated for the ESS-7 Photometer task, however, most of the work consisted of design and engineering support resulting in drawings and specifications*

which were prepared by MEE-12 personnel. There were no technical papers or patents generated by Optomec personnel as a result of this work, and all work defined in the contract was completed.

REPORT NUMBER: LA-SUB-93-156
ACCESSION NUMBER: DE-96-000174

Orr, J.S., H. Gordon and H. Orr. “Vanadium Dioxide Protective Devices.” Final technical report.
Dunfermline (Scotland): OCLI/Optical Coatings Ltd., June 1989. 33p.

Abstract: This development contract has been carried out in order to answer the increasing requirement for protection of sensitive infrared detectors from pulsed laser radiation in the military environment. It has been the concern of this project to develop a protective device for use in the 8-12 micron wavelength region. The approach in this case has been to exploit the well established optical properties of vanadium dioxide thin films in the infrared. This report presents in detail the equipment and methods used to obtain thin films of vanadium dioxide for incorporation in protective devices. A significant development effort has been directed at the inclusion of switching films in antireflection coatings for the 8-12 micron band. The subject of this contract was the development of vanadium dioxide optical switches. The aim was to further develop the reactive sputtering process for deposition of vanadium dioxide. Vanadium dioxide can now be deposited on germanium as well as silicon and has been fully characterized. The process stability, repeatability and the quality of the vanadium dioxide has been significantly improved. In particular the optical scatter has been reduced and the dynamic range has been increased. Devices incorporating vanadium dioxide have been manufactured to the required specification and indications are that the devices should fulfill their intended purpose.

ACCESSION NUMBER: AD-A212 018

Osgood, Richard M., Jr. “The Interaction of UV-Laser Radiation With Metal and Semiconductor Surfaces.” Final Report. 15 January 1989 – 14 January 1992.
Columbia University, NY: Microelectronics Science Laboratory, 26 May 1992. 80p.

Abstract: This report describes progress in a program to understand the fundamentals of UV laser interactions with solid surfaces. In the first, using the previously developed optical probes, we have made the first measurements of the surface photo- dissociation cross section, its yield, its wavelength dependence, and its dependence on surface conditions for two important metal-alkyl precursors. Second, we have successfully initiated a substantial new program in UV-laser photoemission for surface probing. This work has included establishing a new, tunable two-photon photoemission apparatus including UHV chamber with an electron detection system, demonstration of a new technique to probe buried interfaces, the use of high-resolution, two-photon spectroscopy to probe surface-condition-dependent changes via image states, and the observation of space-charge-limited effects on surface photoionization spectroscopy.

ACCESSION NUMBER: AD-A253 510

O'Shea, P.G. “Linear Accelerator in the Space: The Beam Experiment Aboard Rocket.” Los Alamos National Laboratory, NM. 1990. 14p. In: Linear Accelerator Conference, Albuquerque, NM, 9-14 September 1990.

Abstract: On July 13, 1989 the BEAM experiment Aboard Rocket (BEAR) linear accelerator was successfully launched and operated in space. The flight demonstrated that a neutral hydrogen beam could be successfully propagated in an exoatmospheric environment. The accelerator, which was the result of an extensive collaboration between Los Alamos National Laboratory and industrial partners, was designed to produce a 10 mA (equivalent), 1 MeV neutral hydrogen beam in 50 (mu)s pulses at 5 Hz. The major components were a 30 keV H(sup (minus)) injector a 1 MeV radio frequency quadrupole, two 425 Mhz RF amplifiers, a gas cell neutralizer, beam optics,

vacuum system and controls. The design was strongly constrained by the need for a lightweight rugged system that would survive the rigors of launch and operate autonomously. Following the flight the accelerator was recovered and operated again on the laboratory.
REPORT NUMBER: LA-UR-90-3411, CONF-90091234-6
ACCESSION NUMBER: DE-91-002347

Ottey, H. Ralph, Michael T. and Fred S. Zusman. "Strategic Defense Initiative Boost Phase Defense Simulator (SDISIM)." In: 1986 Summer Computer Simulation Conference, Reno, NV, July 28-30, 1986. San Diego, CA: Society for Computer Simulation, 1986, p. 1022-1028.
Abstract: The structure and operation of the SDI simulator are examined. The simulator is a detailed simulation of the boost phase defense used to evaluate SDI architecture and doctrines against ICBMs. The simulation includes satellite-based passive and active sensors, hard-body trackers and illuminators, directed energy weapons, semiactive homing kinetic energy weapons, and battle management architecture. The functions of the input processing, satellite orbit/ICBM trajectory initialization, battle simulation, and statistical postprocessing programs are described. Consideration is given to battle management decision processes, engineering, physical, and mathematical models included in the simulator, and model inputs and outputs.

Otto, J. and W.B. Matkin. "AMC-SWMO Countermeasures Study." Volume 4. Guide to Army Smart Weapon Testing Issues. Final technical report. 29 September 1991-15 June 1992. Chicago, IL: Tactical Weapon Guidance and Control Information and Analysis Center, June 1992. 106p.
See also Volume 1, **AD-A263 833**.
Abstract: This Guide to Army Smart Weapon Testing Issues is a primer intended primarily for the developmental engineers in the smart weapon program management offices who are responsible for organizing smart weapon development tests. Much of the information in this guide is also relevant to the ground vehicle developer. The document examines a number of issues, suggestions, and general principles relevant to smart weapons. The information contained is based primarily on numerous interviews with experienced Army smart weapon testers.
REPORT NUMBER: AMSMICR-SW-92-09
ACCESSION NUMBER: AD-A265 786

"Overview of Defense Applications of ICF (Inertial Confinement Fusion)." Livermore, CA: Lawrence Livermore National Laboratory, 15 August 1989. 9p.
Abstract: The objective of the Inertial Confinement Fusion (ICF) Program is to demonstrate a significant fusion capability in the laboratory. The applications of ICF are broad and numerous, ranging from basic and applied science to weapons physics and weapons effects to energy production and eventually space power and propulsion. This paper is limited to a brief summary of the applications of ICF to defense programs, and in particular, the nuclear weapons R & D and technology base. While relevant weapons physics experiments are currently conducted using the Nova laser, the ultimate contribution of ICF in this area will be a Laboratory Microfusion Facility (LMF) in which fusion yields of 100 to 1000 MJ, provided in a single experimental shot, can be used to attain the near-term applications.
REPORT NUMBER: UCID-21837
ACCESSION NUMBER: DE-90-005745

Pace VanDevender, J. "Pulsed Power, ICF, and SDI." Albuquerque, NM: Pulsed Power Science, Sandia National Labs., 1985. In: Proceedings of the Symposium

on Lasers and Particle Beams for Fusion and Strategic Defense, Rochester, NY, 18-19 April 1985 p. 57-72. Fusion Power Associates; Gaithersburg, MD, 1985.
Abstract: Pulsed power technology has been developed over many years for nuclear weapon effects simulation, inertial fusion, and directed energy. Every four years there is a factor of ten increase in power available, and one is now near the 100 TW, couple of million joule mark. A million joules (MJ) is the energy required to kill a booster and 100 TW is sufficient for studying physics relevant to inertial confinement fusion (ICF) or the Strategic Defense Initiative (SDI). The applications of this technology are many. Pulsed power should be viewed as a basic technology for making electron beams, X-rays, and ion beams. Applications include ICF, plasmoid directed energy weapons, X-ray lasers, electron beams as directed energy weapons, and microwave weapons.

Parazzoli, C.G. et al. “Stimulated Rotational Raman Scattering.” Final Report. September 1, 1986-March 31, 1989. El Segundo, CA: Hughes Aircraft Co., Electro-Optical and Data Systems Group, 31 March 1989. 230p.
Abstract: The document summarizes the work performed on DOE Contract Number AC03-86SF16495 by the Electro-Optics And Data Systems Group of Hughes Aircraft Company. The goal of this Stimulated Rotational Raman Scattering (SRRS) processes on high energy laser directed energy weapon systems. The program had three main objectives; achieving an accurate description of the physical processes involved in SRRS; developing a numerical algorithm to confidently evaluate SRRS-induced losses in the propagation of high energy laser beams in the uplink and downlink segments of the optical trains of various strategic defense system scenarios; and discovering possible methods to eliminate, or at least reduce, the deleterious effects of SRRS on the energy deposition on target. This document describes the accomplishments of the DOE program and is divided into the following sections: The first section discusses the motivation for the accomplishments of the DOE program; then discussed is the Semiclassical Theory Of Non-Resonant SRRS For Diatomic Homonuclear Molecules; and then the following appendices; Calculation of the Dipole Transition Reduced Matrix Element, Guided Tour of Hughes SRRS Code, Running the Hughes SRRS Code, and Hughes SRRS Code Listing.
REPORT NUMBER: DOE/SF-16495/T2
ACCESSION NUMBER: DE-89-016427

Peigen, Yang. “Development of Tactical Laser Weapons.” Wright-Patterson AFB, OH: National Air Intelligence Center, April 1996. 16p. Translation of Jiguang Jishu (**Laser Technology**) (China), June 1991, v. 15, n. 3, p. 175-179.
Abstract: Recent developments of tactical laser weapons are reviewed in detail.
REPORT NUMBER: NAIC-ID (RS) T-0142-96
ACCESSION NUMBER: AD-A309 758

Penatzer, Jeffery L. “Enhancement of Multiple Target Track Simulation.” Final technical report. May 1989-April 1990. Rome, NY: Analytical Systems Engineering Corp., August 1992. 37p.
Abstract: The Enhancement of Multiple Target Track Simulation task had as its primary objective the development of an integrated simulation of Strategic Defense Initiative (SDI) Acquisition, Tracking, Pointing, and Fire Control (ATP-FC) functions from previously developed simulations of a subset of the individual functions which would be required for a complete end-to-end simulation of a space-based Directed Energy Weapon (DEW) platform. The functions integrated were the Target Detection, Multiple Target Tracking (MTT), and Target Sequencing functions. Additionally, the Plume-to-Hardbody Handover function was partially integrated. The task consisted of the following subtasks: (1) Incorporation of previously developed target sequencing algorithms (Nearest Neighbor and Farthest Insertion) into a previously existing MTT

simulation, (2) Investigation and incorporation of an improved target detection algorithm to replace the target detection algorithm that was included with the original previously existing MTT simulation, and (3) Incorporation of previously developed Plume-to-Hardbody handover algorithms into the combined MTT and target sequencing simulation. This report summarizes the work performed in accomplishing these three subtasks.

ACCESSION NUMBER: AD-A257 224

Penrod, Shawn L. “An Endo-Atmospheric Hypervelocity Intercept System.” Final report. 1977-1988. Annapolis, MD: Naval Academy, 10 June 1988. 117p.

Abstract: This study examines the feasibility and practicality of using clouds of hypervelocity pellets to intercept and disable a generic air target. The Directed Energy Projectile Warhead which accelerates these pellets, uses an unconventional design to attain speeds an order of magnitude above those of conventional high explosive warheads. The DEPW is fitted to a conventional intercept missile to put the target in effective range of the warhead, which then detonates, and launches the pellets very much like a hypervelocity shotgun. An extensive three-dimensional computer simulation was developed using ACSL(Advanced Computer Simulation Language) and FORTRAN. The program models the terminal homing phase of a missile intercept to evaluate the effectiveness of different guidance laws used to align the warhead with the projected intercept point. After a favorable geometry has been achieved, the warhead is detonated and the lethality of impact between the target and hypervelocity pellet cloud is evaluated. Overall effectiveness of this system is shown to depend on the pointing accuracy of the warhead and the firing range. No insurmountable obstacles are foreseen in developing a suitable guidance and aiming algorithm. A valuable tool to evaluate design options has also been developed.

REPORT NUMBER: USNA-TSPR-153
ACCESSION NUMBER: AD-A200 403

Perez, C.L. and J.O. Johnson. “Vulnerability Assessment of a Space Based Weapon Platform Electronic System Exposed to a Thermonuclear Weapon Detonation.” Oak Ridge National Laboratory, TN. 1994. 9p. In: International Conference on Radiation Shielding (8th), Arlington, TX, 24-27 April 1994.

Abstract: Rapidly changing world events, the increased number of nations with inter-continental ballistic missile capability, and the proliferation of nuclear weapon technology will increase the number of nuclear threats facing the world today. Monitoring these nation's activities and providing an early warning and/or intercept system via reconnaissance and surveillance satellites and space based weapon platforms is a viable deterrent against a surprise nuclear attack. However, the deployment of satellite and weapon platform assets in space will subject the sensitive electronic equipment to a variety of natural and man-made radiation environments. These include Van Allen Belt protons and electrons; galactic and solar flare protons; and, neutrons, gamma rays, and X-rays from intentionally detonated fission and fusion weapons. In this paper, the MASH vl.0 code system is used to estimate the dose to the critical electronics components of an idealized space based weapon platform from neutron and gamma-ray radiation emitted from a thermonuclear weapon detonation in space. Fluence and dose assessments were performed for the platform fully loaded, and in several stages representing limited engagement scenarios. The results indicate vulnerabilities to the Command, Control, and Communication (C) bay instruments from radiation damage for a nuclear weapon detonation for certain source/platform orientations. The distance at which damage occurs will depend on the weapon yield (n,(gamma)/kiloton) and size (kilotons).

REPORT NUMBER: CONF-940424-16
ACCESSION NUMBER: DE-94-007229

Perram, Glen P. “Visible Chemical Lasers.” In: Lasers ’89; Proceedings of the International Conference, New Orleans, LA, December 3-8, 1989. McLean, VA: STS Press, 1990, p. ??

Abstract: Applications for visible chemical lasers, which show great potential as highly efficient, wavelength agile, deployable, high brightness laser systems are discussed. These systems provide important and unique opportunities for both directed energy weapons and diagnostic applications. Issues discussed in this paper include concepts, requirements and approaches to visible chemical lasers. A survey of candidate energy transfer system is also given, with emphasis on excited NF and nitrogen driven lasers. The long term, low level investment in this technology area during the past decade firmly establishes the opportunity for a lasting demonstration in the near term.

“Perspectives on the American Physical Society Directed Energy Report.” Washington, DC: Strategic Defense Initiative Organization, May 1987. 48p.

Abstract: The American Physical Society (APS) report on the Science and Technology of Directed Energy Weapons has prompted considerable public comment. In order to provide a brief summary of the report contents and the general conclusions which it has generated, as well as to indicate the range of positive and negative criticism which has resulted, the material contained herein has been assembled. Preceding a number of short extractions from various sources is a one-page description of positions which have been taken on different aspects of the report, including some SDIO perspectives. A listing of the selected material is also provided. This office fully supports informed, vigorous debate on the utility of, as well as the status and development time-table for, directed energy weapons. It is hoped that the attached information can be used as a starting point for further discussions, both classified and unclassified.

ACCESSION NUMBER: AD-A345 227

Pettersson, Goran S. “Illustrated Overview of ESM and ECM Systems.” Monterey, CA: Naval Postgraduate School, September 1993. 134p.

Abstract: This thesis gives an overview of electronic support measures (ESM) and electronic countermeasures (ECM) systems. The objective is to give the intended reader, students of the EW curriculum new to the subject, an introduction to several different electronic warfare systems. The thesis consists of seven chapters discussing different areas of EW. The first two chapters introduce the reader to the definitions of EW and the threat which EW equipment is designed to counter, The following two chapters are a presentation of typical ESM and ECM systems. The final three chapters cover the integration of ESM and ECM systems as well as two subjects, suppression of enemy air defense and directed energy weapons, which differ from the typical ECM systems. Included with each chapter describing systems is a conclusion section which discusses possible future developments for the group of systems.

ACCESSION NUMBER: AD-A275 517

Pevler, A.E. “Security Implications of High-Power Microwave Technology.” In: 1997 International Symposium on Technology and Society, Technology and Society at a Time of Sweeping Change. Proceedings. Glasgow, UK, 20-21 June 1997. New York, NY: IEEE, 1997. p. 107-111.

Abstract: The development of high-power microwave (HPM) weaponry, and its proliferation into subversive organizations, offers the means to commit the “perfect crime.” HPM attacks typically leave no residual evidence and their effects can range from nuisance to catastrophic. The paper highlights some of the unusual aspects of HPM technology and raises issues regarding security of airliners, commercial power systems and other targets. It also discusses strategies to begin mitigating the risks.

Peyser, T.A. et al. “Reduction of Three-Halved Harmonic Emission from Laser-Produced Plasmas With Broadwidth Induced Spatial Incoherence at 0.53 Microseconds.” Memorandum Report 6798. Washington, DC: Naval Research Laboratory, 24 May 1991. 27p.

Abstract: Measurements of the omega sub 0/2 emission from Laser irradiated targets at 0.53 microns were made at three angles over a wide range of Laser bandwidths with and without induced spatial incoherence (ISI) echelons. The 3 microns/2 emission was found to be correlated with hard x rays but not Raman spectra suggesting that the 3 omega sub 0/2 radiation was due to two plasmon decay. Reduction of both 3 omega sun 0/2 emission and the accompanying hard x rays by ISI required five to ten times larger bandwidths than needed to suppress stimulated Raman scattering and stimulated Brilloin scattering.

REPORT NUMBER: NRL-MR-6798
ACCESSION NUMBER: AD-A235 798

Phillips, Robert M. “Modulatable Thin Film Emission Space Gun.” Final Technical Report. October 1985-June 1986. Campbell, CA: Star Microwave, November 1987. 54p.

Abstract: The objective of this research program was to determine the feasibility of using a Spindt type thin film emitter chip to produce amperes of low voltage modulated current at tens of kilovolt beam voltage for a space application. The specific requirement was for a pulse modulated column of electrons of 10 amperes current at 50 kilovolts voltage. A design effort determined that a 2-inch diameter chip would be required to provide this current with conservative emission current density. A conceptual design was developed consisting of an array of emitting regions producing beamlets which were to be accelerated through a gridded or perforated anode at approximately 3 kilovolt voltage, followed by post-acceleration to 50 kilovolts. Feasibility was to be demonstrated by using smaller (1/2-inch square) standard emitter chip of the type produced by SRI International for their field emissions research program. This chip was to be tested to the same current density as would be required of the 2-inch chip. A test electron gun employing a standard emitter chip was designed and fabricated based on the results of a computer-derive electron optics model. Of five emitter chips started only two were successful and were delivered for use in the test gun. One chip was lost during assembly of the test gun due to breakdown of the chip, apparently from RF leakage while a welding process was being performed. After modifying the construction procedure, the test gun was successfully assembled. However, during tests, this chip failed catastrophically at one percent of the current emission which was required to demonstrate feasibility of the approach.

ACCESSION NUMBER: AD-A189 279

“Physics Division Progress Report, October 1, 1987-December 31, 1988.” Los Alamos National Laboratory, NM. December 1989. 80p.

Abstract: This report provides selected accounts of significant progress in research and development achieved by Physics Division personnel during the period October 1, 1987, through December 31, 1988. It also provides a general description of the goals and interests of the Division, very brief descriptions of projects in the Division, and a list of publications produced during this period. The report represents the three main areas of experimental research and development in which the Physics Division serves the needs of Los Alamos National Laboratory and the nation in defense and basic sciences: (1) fundamental research in nuclear and particle physics, condensed-matter physics, and biophysics; (2) laser physics and applications, especially to high-density plasmas; and (3) defense physics, including the development of diagnostic methods for weapons tests, weapon-related high energy-density physics, and programs supporting the Strategic Defense Initiative.

REPORT NUMBER: LA-11699-PR
ACCESSION NUMBER: DE-90-005718

Pierre, J.M. “Integration of Electromagnetic Threats.” Alexandria, VA: Defense Nuclear Agency, 1994. In: Electromagnetic Environments and Consequences. Proceedings of the European Electromagnetics International Symposium on Electromagnetic Environment and Consequences, EUROEM 94, Bordeaux, France, 30 May – 3 June 1994. (Gramat, France: EUROEM 1995). p3-13. vol. 1.

Abstract: During the Cold War era, the nuclear weapons effects community made significant contributions to the understanding of hostile electromagnetic effects on many types of military systems. In the United States, these contributions were made possible through sustained government investment especially by the Department of Defense (DoD), in fundamental and applied research on electromagnetic pulse (EMP) environments, system interactions, and protection methods. As the likelihood of large scale nuclear war has diminished, the resources devoted to traditional EMP research has also declined. The irony in this development is that the proliferation of weapons of mass destruction continues to rise steadily. Current circumstances provide the nuclear effects community with a unique opportunity to apply its talents to new challenges posed by changing threats and declining resources. The electromagnetics (EM) community must work together and be creative in developing affordable solutions to meet existing and future needs. A systematic and integrated approach for dealing with a wide variety of nuclear and nonnuclear electromagnetic environments holds great promise for both improved performance and cost savings. The individual and collective cooperation of members of the international EMP and the electromagnetic effects community is essential if such an approach is to be successful.

Pimentel, K.D., D.T Gavel and J.W. Roblee. “Preliminary Findings for Integrated Modeling and Simulation of Directed Energy Weapons.” Livermore, CA: Lawrence Livermore National Laboratory, 22 May 1986. 8p. In: 2nd European Simulation Congress, Antwerp, Belgium, 9 September 1986.

Abstract: A preliminary study was recently completed at Lawrence Livermore National Laboratory of the issues important to the integrated modeling and simulation of future directed energy weapon (DEW) space platforms. The preliminary study comprised three parts: (1) a preliminary survey of existing computer codes used for integrated modeling and simulation; (2) work by a multidisciplinary team on a simple optical beam expander model to motivate cooperation in the three technical areas of space structures, optics, and control systems; and (3) identifying needs in integrated modeling and simulation for DEW systems. Results of this study indicate that much of the technology for end-to-end modeling and simulation of DEW space platforms may be in hand today. However, there may be critical needs in certain modeling and simulation areas, particularly in the package integration and computer/human interface areas, that are beyond the current state of the art to meet required levels of performance.

REPORT NUMBER: UCRL-93-765, CONF-8609113-1
ACCESSION NUMBER: DE-86-011636

Pocha, M.D. and W.W. Hofer. “Photoconductive Switching for High Power Microwave Generation.” Livermore, CA: Lawrence Livermore National Laboratory, October 1990. 20p. In: OPTCON ‘90: SPIE Symposium on Laser Science and Applications of Optics, Boston, MA, 4-9 November 1990.

Abstract: Photoconductive switching is a technology that is being increasingly applied to generation of high power microwaves. Two primary semiconductors used for these devices are silicon and gallium arsenide. Diamond is a promising future candidate material. This paper discusses the important material parameters and switching modes, critical issues for microwave generation, and future directions for this high power, photoconductive switching technology.

REPORT NUMBER: UCRL-JC-104841, CONF-9011125-4

ACCESSION NUMBER: DE-91-005433

Pocha, M.D. and W.W. Hofer. “Photoconductive Switching for HPM Generation.” Lawrence Livermore, CA: Livermore National Laboratory, 1990. 22p. In: National Conference on High-Power Microwave Technology (5th), West Point, NY (USA), 10-15 June 1990.

Abstract: Photoconductive switching has been explored at LLNL and demonstrated to be a viable technology for high power microwave (HPM) generation. This technology enables the development of compact, portable, and efficient HPM sources. At LLNL we have successfully switched 35 KV in <200 ps using laser triggered, 1 (times) 5 (times) 20 mm GaAs switches. Based on these results we are developing an HPM generator with applications for HPM weapons and high power, wideband radar. The paper will discuss the physics limits and tradeoffs in the application of this technology. Among the topics discussed will be switching efficiency, candidate switch materials, laser requirements, applicable laser technologies, generator configurations, and cooling requirements and techniques. In addition to presenting theoretical and practical considerations, the paper will discuss on-going work at LLNL and elsewhere.

REPORT NUMBER: UCRL-JC-102831, CONF-9006179-6
ACCESSION NUMBER: DE-91-005398

Poulsen, P., P.A. Pincosy and G.J. Burke. “General Limits on the Performance of High Power Radiators.” Livermore, CA: Lawrence Livermore National Laboratory, October 1994. 6p. In: Conference on High Power Microwaves (7th), Monterey, CA, 31 October 1994.

Abstract: Performance of high power radiators of electromagnetic energy can be limited by constraints such as those due to voltage holding, corona power loss, and antenna impedance and efficiency. The issues are addressed in such a way that general limits on the electric field and energy at a distance is obtained as a function of wavelength, pulse duration, and size of the radiating element. We address the relation between the frequency content of the driving pulse and the complex impedance of the antenna; the importance of minimizing the antenna impedance and therefore limiting the antenna input voltage is clearly shown. For example, driving the antenna at a resonance with a simple oscillating waveform is shown to allow the radiation of energy with two to three times the efficiency of a mono-polar pulse input. With this information, the prospects for a successful system design of a given size to deliver a specified amount of radiation to a target at a given distance can be quickly assessed.

REPORT NUMBER: UCRL-JC-117133, CONF-9410341-1
ACCESSION NUMBER: DE-95-010732

Prantil, V.C. “Response of a Thin Cylindrical Shell Under Lateral Impulse Loads.” Albuquerque, NM: Sandia National Labs., March 1988. 78p.

Abstract: In support of the current directed energy weapons program investigating lethality levels of short pulse width lasers, a combined analytical/experimental program has been underway to predict large deformation response of conceptual ballistic missile designs to impulsive loading. Both unpressurized cylindrical shell models have been analyzed and tested. Such impulsively loaded structures exhibit large scale plastic deformation and local dynamic pulse buckling instability which subsequently influence the loaded surface collapse. Impulse loads were simulated using both lead spray and light initiated high explosive techniques. Finite element calculation using a modified form of the Hughes-Liu shell element verify several characteristics of the structural response observed in experiments. The role of the computational results in identifying lethal impulse levels and response modes is described. In addition, the requirements for initial imperfections and fine mesh discretization for these problems are discussed.

REPORT NUMBER: SAND-87-8229
ACCESSION NUMBER: DE-88-008071

Prishchepenko, A.B., V.V. Kiseljov and I.S. Kudimov. “Radio Frequency Weapon at the Future Battlefield.” Moscow, Russia: Central Science and Research Institute for Chemistry and Mechanics, 1994. In: Electromagnetic Environments and Consequences. Proceedings of the European Electromagnetics International Symposium on Electromagnetic Environment and Consequences, EUROEM 94, Bordeaux, France, 30 May – 3 June 1994. (Gramat, France: EUROEM 1995). p. 266-271. vol. 1.

Abstract: The incapacitation power of a radio frequency weapon (RFW) consists of inducing in the target's circuits fatal current and voltage for solid state elements (SSE). Though the energy required for such effects in SSE is small (microjoules), the electromagnetic energy decreases substantially before reaching a critical SSE. The authors discuss the basic technical characteristics of RFWs which are based on vircators, magnetrons, high explosive chemical energy in direct converters using magnetic field compression, etc. In particular, the authors discuss the microwave sources. The authors then discuss the conceptual aspects of RFW application.

Pritchard, R.H. “SDI Weapons Simulation-'From Light to Rocks.'” Huntsville, AL: BDM Corp., 1987. In: Proceedings of the 1987 Summer Computer Simulation Conference, Montreal, Quebec, Canada; 27-30 July 1987. San Diego, CA: SCS, 1987. p. 931-932.

Abstract: Because many of the weapons proposed for SDI cannot ever be operationally tested, simulations are playing a critical role in the development of both kinetic energy weapon (KEW) and directed energy weapon (DEW) concepts. Moreover, even though other SDI subsystems (such as SATKA and BM/C/sup 3/) must also be simulated, it is the weapon that lies at the heart of a credible strategic defense. This paper gives an overview of SDI simulations that places the role of weapon simulation in proper perspective.

“Proceedings of the Eighth DOD Conference on DEW Vulnerability, Survivability, and Effects.” SURVIAC (Survivability/Vulnerability Information Analysis Center), October 1992. 2 volumes.

Abstract: This conference, held in June 1992, provided a forum for discussion, interchange, and debate of accomplishments, discoveries, and issues in the areas of vulnerability, survivability, and effects of Directed Energy Weapons (DEW) such as lasers, standards, laser illumination tests, hazards and medical implications, capabilities, requirements, and myths. The conference was particularly significant because of the progress made in laser technologies and in the critical military use of new materials and substances affected by these new technologies. Volume I of the proceedings details the general session and numerous presentations given on structures (tactical and space), eye and personnel protection, space platforms, and sensors. Volume II presents poster papers from the conference. [Proceedings of the fifth through seventh DEW conferences are also available from SURVIAC].

http://surviac.flight.wpafb.af.mil

Qiwan, Fang, Yin Zhixiang and Jiang Chuanfu. “Menace of Anti-Ship Missiles and Shipborne Laser Weapons.” Wright-Patterson AFB, OH: National Air Intelligence Center, 22 July 1996. 20p. Translation of **Jiguang Jishu** (**Laser Technology**) (China), December 1995, v. 19, n. 6, p. 365-370.

Abstract: This paper discusses the menace of antiship missiles, the difficulties of operational shipborne short range antimissile defense systems, and a survey of the development of shipborne laser weapons.

REPORT NUMBER: NAIC-ID (RS) T-0337-96
ACCESSION NUMBER: AD-A313312

Quick, Dennis D. “Simulations of the High Average Power Selene Free Electron Laser Prototype.” Monterey, CA: Naval Postgraduate School, June 1994. 63p.

Abstract: Free electron laser (FEL) technology continues to advance, providing alternative solutions to existing and potential problems. The capabilities of an FEL with respect to tunability, power and efficiency make it an attractive choice when moving into new laser utilization fields. The initial design parameters, for any new system, offer a good base to begin system simulation tests in an effort to determine the best possible design. This is a study of the Novosibirsk design which is a prototype for the proposed SELENE FEL. The design uses a three-section, low-power optical klystron followed by a single-pass, high-power radiator. This system is inherently sensitive to electron beam quality, but affords flexibility in achieving the final design. The performance of the system is studied using the initial parameters. An FEL, configured as a simple, two section optical klystron is studied to determine the basic operating characteristics of a high current FEL klystron.

ACCESSION NUMBER: AD-A280 780

Ramos, Luis. “Atmospheric Propagation Simulations and Boeing’s High Average Power Free Electron Laser.” Monterey, CA: Naval Postgraduate School, 1995. 65p.

Abstract: The development of a high average power FEL for military applications, whether shipboard or not, represents a significant advancement in technology over present weapons system design. The FEL has significant advantages over conventional kinetic systems and other classical high-energy laser systems. The rapid response, wavelength tunability, and infinite magazine make the FEL a highly desirable shipboard weapon system. The initial pan of this thesis examines the advantages of a FEL over a conventional kinetic weapon. Section II explores the atmospheric phenomenon that affects the propagation of a laser beam enroute to its target. Section III presents the Boeing FEL proposal followed by the theory of the FEL. Lastly, in Sections V, VI, simulations are conducted to analyze the FEL’s feasibility.

ACCESSION NUMBER: AD-A305 947

Rauh, R.D. and Gerhard L Holleck. “Development of a Nickel Oxide/Hydrogen Multilayer Bipolar Battery for Pulsed Power.” Norwood, MA: EIC Labs., Inc., April 1987. 3p.

Abstract: Spaced-based missile defense systems will require sources of pulsed power to operate prospective directed energy weapons. In principle, an electrochemical power source can provide this power at a much lower weight than alternative magnetic or electric field devices (capacitors or inductors). However, advances must be made in high rate thin film electrode materials and in battery design. In the present program we are investigating electrochemical capacities under pulsed conditions for two promising materials (1) LaNi5 which acts as hydrogen storage anode with high hydrogen diffusion rates and (2) a hydrated nickel oxide cathode with optimized mixed ionic and electronic conductivity. Thin films were prepared by reactive sputtering, vapor disposition, anodization of nickel and electrochemical precipitation of nickel hydroxide.

ACCESSION NUMBER: AD-A181 004

Reed, Harry L., Jr. “Small Force Effectiveness of Direct Fire Weapons: Model Analysis.” Final report. 1 February-1 June 1990. Battelle Columbus Labs., OH. September 1990. 102p.

Abstract: This report discusses three modified versions of the TANKWARS model: (1) a version which uses an input table of priorities that allows the option of breaking off firing for newly appearing high priority targets and allows prioritization among targets that are already engaged by the various members of the team and that are of various significance, (2) a version which

allows a more realistic meeting engagement in which both sides can advance and also have defending vehicles remain in hull defilade; and (3) a version in which the defending forces can operate in a pop up mode. In this mode, a nonfiring vehicle detects targets and transfers them to fully defilade tanks which then pop up to hull defilade, fire and pop down.

REPORT NUMBER: BRL-CR-641
ACCESSION NUMBER: AD-A226 322

Rees, D.E. "Models to Evaluate Magnicon Architectures and Designs Suitable for High-Perveance Beams." Thesis (Ph.D.) Los Alamos National Laboratory, NM. March 1994. 271p.

Abstract: The magnicon, a new high-power, radio frequency (rf) deflection- modulated amplifier, was recently developed at the Institute for Nuclear Physics in Novosibirsk, Russia. The first magnicon achieved a peak output power of 2.6 MW for 50-(mu)s pulses at a frequency of 915 MHz with a dc-to-rf conversion efficiency of 73%. The conversion efficiency achieved by the original magnicon represents a significant improvement over state-of-the-art conventional velocity- and density-modulated devices. Therefore, if properly exploited, the magnicon could substantially reduce the operating expenses of industrial, scientific, and military facilities that require large amounts of RF power. This dissertation describes the operational principles of the magnicon, provides small-signal analytical theory (where practical), presents a large-signal numerical model to characterize magnicon performance, and then utilizes this model to investigate the characteristics of the component magnicon structures. Using these modeling tools, the first-generation magnicon architecture is analyzed for its performance sensitivity to electron-beam size and is found to support beams of only limited diameter. Finally, an alternate magnicon geometry, called a "uniform-field" magnicon, is presented and shown to support beams of larger diameter.

ACCESSION NUMBER: DE-94-009370

Reid, D.W. "Thermal Management of an Accelerator System in Space." Los Alamos National Laboratory, NM. 1990. 14p. In: Prospector 1: Key Issues in Space Technology, Park City, UT, 20-22 March 1990.

Abstract: For the past several years the Accelerator Technology Division at Los Alamos National Laboratory has been working under Strategic Defense Initiative sponsorship to develop a Neutral Particle Beam (NPB) weapon system. A weapon grade NPB system generates 10s of MWs of waste energy which must be dissipated in some fashion. There are only three ways that heat may be dissipated in space. The first is to expel a hot gas or liquid from the spacecraft. The second method is to directly radiate the generated heat to deep space. The third method is to dissipate the heat in some type of thermal mass storage. The objective of this workshop is to try to determine the best way to dissipate MWs in space.

REPORT NUMBER: LA-UR-90-2159, CONF-9003178-1
ACCESSION NUMBER: DE-90-013153

"Report of the Defense Science Board Task Force on Military System Applications of Superconductors." Final report. Washington, DC: Defense Science Board, October 1988. 88p.

Abstract: The Task Force found a number of superconductivity applications that could result in significant new military capabilities, including electronics and high power applications. In particular, superconducting materials could enable significant military improvements in: Magnetic Field Sensors with greatly increased sensitivity for improved detection and identification capability; Passive Microwave and Millimeter-wave Components enabling increased detection range and discrimination in clutter; Staring Infrared Focal Plane Array sensors incorporating superconducting electronics permitting significant range and sensitivity increases over current scanning IR sensors; Wideband Analog and Ultra-Fast Digital Signal Processing for radar and optical sensors; High Power Motors and Generators for ship and aircraft propulsion leading to: decreased displacement; drive system flexibility; increased range; or longer

endurance on station; Magnets/Energy Storage for high power microwave, millimeter-wave or optical generators (e.g., free electron laser); capability for powering quiet propulsion systems; Electro-Magnetic Launchers capable of launching hypervelocity projectiles for antiarmor weapons and close-in ship defense weapons; and Magnetohydrodynamic (MHD) Propulsion enabling ultra quiet drives for submarines, torpedoes, and surface ships.

ACCESSION NUMBER: AD-A201 125

"Report to the Congress on the Strategic Defense Initiative." Washington, DC: Strategic Defense Initiative Organization, April 1988. 320p.

Abstract: TABLE OF CONTENTS : (1.0) PROGRAM IN PERSPECTIVE; (2.0) PROGRAM STRUCTURE AND STRATEGY; (3.0) PROGRAMS AND SYSTEMS; (3.1) SDS Phase I; (3.2) SDS Engineering and Support; (3.3) National Test Bed; (3.4) BM/C3 Program; (3.5) Theater Missile Defense; (3.6) Operations Interface; (3.7) Funding Impact; (4.0) TECHNOLOGY; (4.1) Surveillance, Acquisition, Tracking, and Kill Assessment Program; (4.2) Kinetic Energy Weapons Technology Program; (4.3) Directed Energy Weapons Technology Program; (4.4) Survivability, Lethality, and Key Technologies Program; (4.5) Innovative Science and Technology Program; (5.0) TEST AND EVALUATION; APPENDIX (A): SDI and the Allies; APPENDIX (B): Soviet Strategic Defense Programs and Soviet Response to SDI; APPENDIX (C): SDI Compliance with the ABM Treaty; APPENDIX (D): SDI Organization and Comptrollership; APPENDIX (E): SDI Technology Applications Program; APPENDIX (F): SDI Technology and Other Defensive Missions; APPENDIX (G): Implications of No ABM Treaty Restriction on the SDI Program.

ACCESSION NUMBER: AD-A321 530

"Report to the Congress on the Strategic Defense Initiative 1990." Washington, DC: Strategic Defense Initiative Organization, May 1990. 177p.

Abstract: This report recounts the progress the SDI program has made over the last several years and describes our plans for the future. One of the biggest breakthroughs occurred recently--the introduction of the Brilliant Pebbles concept into the space-based portion of the defense architecture. Preliminary cost estimates and effectiveness analyses indicate that deployment of Brilliant Pebbles as the space-based layer of a Phase One Strategic Defense System could allow savings of $14 billion from previous estimates, reducing the cost of an initial system from $69 billion to approximately $55 billion. In 1989, we launched the Beam Experiment Aboard a Rocket (BEAR), which demonstrated propagation of a particle beam in space. Also in 1989, we witnessed the first firing of the Alpha chemical laser. In 1990, we plan to achieve even more significant testing milestones. In January, we launched the first High Endo-Atmospheric Defense Interceptor (HEDI) test and demonstrated the ability to cool the interceptor's forebody and sensor window. We are demonstrating defensive technologies that we believe offer the potential for moving toward a more stable relationship with the Soviet Union while reducing offensive forces. In sum, our efforts to demonstrate defensive technologies, to modernize our offensive forces and to work toward beneficial arms control agreements are fully integrated and mutually reinforcing.

ACCESSION NUMBER: AD-A224 950

Restivo, Rick A. "Free Electron Laser Weapons and Electron Beam Transport." Master's thesis. Monterey, CA: Naval Postgraduate School, June 1997. 70p.

Abstract: The Navy is exploring the possibility of using a MW class free electron laser (FEL) as a ship self-defense weapon against anti-ship missiles. The Navy has helped fund the construction of a KW average power FEL and has held workshops to discuss weapons class FELs. A design workshop resulted in two possible MW FELs which are examined. One of these designs, the MW regenerative amplifier FEL, is looked at further to determine the feasibility of its design parameters. The second design, the MW oscillator FEL, presents a challenge in

understanding the electron beam transport phenomena known as coherent synchrotron radiation (CSR). A workshop concluded that CSR is potentially disruptive in the electron beam recovery in the oscillator design. Possible CSR experiments are analyzed to help the Navy's Directed Energy office determine which, if any, CSR experiment will be useful.

ACCESSION NUMBER: AD-A333 358

Robiscoe, R.T., D.D. Cobb, and W.B. Maier. “Onboard Detection of Intrinsic Ly(alpha) Radiation from a Neutral Particle Beam.” Los Alamos National Laboratory, NM. May 1990. 27p.

Abstract: We consider photometers onboard a hydrogen neutral particle beam (NPB) space platform which monitor the intrinsic radiation from excited atoms in the NPB in flight. The radiation of choice is the Lyman (alpha) (Ly(alpha)) line 1216 A, emitted when the beam's (approx. equal) 7% fraction of H (2S) atoms is motionally quenched in the earth's magnetic field. At nominal 20-MeV NPB energy, the Ly(alpha) radiation persists at 1% of its initial intensity out to 100 m along the beam, and is red-shifted to 1494 A when viewed form behind the exciting NPB pulse. A photosensitive detector with a (approximately) 5(degree) field of view, placed adjacent to the NPB exit port and viewing the NPB pulse along its limb, shows marked changes in detected Ly(alpha) intensity when the NPB axis shifts direction. If the NPB pulse is nominally 50 MA times 100 (mu)s, and if the detector is a 1-cm(sup 2) array of 25 (mu)m times 25 (mu)m photosensitive pixels located in the focal plane of an 8-cm diam. f/1 LiF lens, then pixels at the brightest part of the beam image are illuminated by up to 2300 Ly(alpha) photons per NPB pulse. The pixel quantum efficiency, optics transmission losses, and a geometric correction for viewing angle reduce the maximum count rate to (approximately) 200 photoelectrons per pixel per pulse under realistic operating conditions, and at a limb-viewing angle (i.e., angle between beam and detector axes) of (approx. equal) 6 mrad. At smaller viewing angles the pixels count rate declines rapidly, but rapidly, but becomes sensitive to small angular shifts in the NPB axis direction. In the limit of shot-noise on the pixel count, and at optimum viewing angle ((approx. equal) 0.54 mrad), we find that a single pixel can sense beam-axis shifts of (approx. equal) (plus minus)50 (mu)rad.

REPORT NUMBER: LA-11776-MS
ACCESSION NUMBER: DE-90-010341

Rongrui, Wang. “Some Advances in U.S. Space Defense Systems.” Wright-Patterson AFB, OH: Foreign Technology Division, 10 December 1991. 17p. Translation of **Jiguang Yu Hongwai** (China) 1989, v.19 n.19 p.15-19.

Abstract: This article, by way of a simple summary, introduces certain aspects of the U.S. Star Wars program which have undergone developments recently as well as experimentation planned in the future. In 1984, the U.S. Defense Department set up a Strategic Defense authority in order to carry out the Star Wars Program and put vigorous effort into the development of directed energy weapon, kinetic energy weapons, as well as research on a set of technologies such as early warning, aiming, tracking, and target recognition. This article, on the basis of openly published U.S. sources, takes a comprehensive look at the status of several areas of development in U.S. space defense systems.

REPORT NUMBER: FT-DID (RS) T-1472-90
ACCESSION NUMBER: AD-A246 038

Rongrui, Wang. “Tactical Laser Weapons and Other Directed-Energy Weapons.” Wright-Patterson AFB, OH: Foreign Aerospace Science and Technology Center, 30 July 1993. 17p. Translation of **Laser and Infrared** (China), 1990, v. 20, n. 5, p. 26-29.

Abstract: No abstract available.

REPORT NUMBER: FASTC-ID (RS) T-0124-93
ACCESSION NUMBER: AD-A267 961

Rose, M. Frank et al. “Limiting Factors for Carbon Based Chemical Double Layer Capacitors.” Auburn Univ., AL. Solid State Sciences Center. November 1993. 11p. In: NASA Lewis Research Center, Space Electrochemical Research and Technology. p. 231-241. [N94-23345]

Abstract: The Chemical Double Layer (CDL) capacitor improves energy storage density dramatically when compared with conventional electrolytic capacitors. When compared to batteries, the CDL Capacitor is much less energy dense; however, the power density is orders of magnitude better. As a result, CDL-battery combinations present an interesting pulse power system with many potential applications. Due to the nature of the CDL it is inherently a low voltage device. The applications of the CDL can be tailored to auxiliary energy and burst mode storages which require fast charge/discharge cycles. Typical of the applications envisioned are power system backup, directed energy weapons concepts, electric automobiles, and electric actuators. In this paper, we will discuss some of the general characteristics of carbon-based CDL technology describing the structure, performance parameters, and methods of construction. Further, analytical and experimental results which define the state of the art are presented and described in terms of impact on applications.

ACCESSION NUMBER: N94-23365

Rose, M. Frank, L.C. Chow and J.H. Johnson. “Thermal Management of Space-Based, High-Power Solid-State RF Amplifiers.” Final report. Los Alamos National Laboratory, NM. 1 August 1990. 172p.

Abstract: The advanced weapons concepts envisioned by the SDIO employed a wide array of highly energetic devices, which due to inefficiencies, generate large quantities of waste heat. Power and thermal management are integrally related. In the vacuum of space, disposing of waste energy is a major problem which can contribute as much as 50% to the overall spacecraft mass and volume. The problem becomes more acute as the temperature at which the energy must be rejected is lowered. In an earlier study, thermal management issues associated with megawatt class RF microwave tubes were explored to determine if there were simple, approximately mass neutral schemes which might be adapted to dispose of the waste energy generated within a tube collector operating in space. The assumptions for that study were: (1) Tubes were in the megawatt class-70% efficient for single simple collector and 90% efficient for depressed collectors, (2) On-board, super critical hydrogen was available at a pressure of 35 bars and a temperature of 35 K. (3) The largest single event run time was 500 seconds. (4) The device would be dormant for long periods of time, be required to become active in tens of seconds followed by long periods of dormancy. (5) The only allowable effluent is hydrogen. (6) System impact must be minimal.

REPORT NUMBER: LA-SUB-96-59
ACCESSION NUMBER: DE-96-015210

Roth, J.R. and Igor Alexeff. “Research on Heating, Instabilities, Turbulence and RF (Radiofrequency) Emission from Electric Field Dominated Plasmas.” Final report. 15 March 1986-14 May 1989. Knoxville, TN: Tennessee Univ., Plasma Science Laboratory, 1 July 1989. 238p.

Abstract: This contract has supported four research programs: 1) a program of research on plasma turbulence; 2) a program of research on plasma heating by collisional magnetic pumping; 3) a research program on the Orbitron submillimeter maser; and 4) the initial phase of a program on plasma cloaking of military targets for protection against radar and directed microwave energy weapons. Progress in these areas is documented in the text of this final report and in the twenty

archival publications included in the appendices to this report. In addition to the above four research areas, we are continuing our work on plasma diagnostic development, and the development of new state-of-the-art data analysis and reduction methods, including software development for online reduction of Langmuir probe, capacitive probe, and other diagnostic information. We are also developing the capability to analyze electrostatic potential fluctuations by the methods of nonlinear dynamics. An important part of our research program has been the training of our graduate and undergraduate research assistants in state-of-the-art methods in the fields of high temperature plasma physics, plasma diagnostics, communications, and related areas.

REPORT NUMBER: AFOSR-TR-89-1226
ACCESSION NUMBER: AD-A212 122

Rotman, Stanley R. and Francis X. Hartmann. "Solid-State Laser Research Report: Energy Transfer in Non-Uniform Codoped Crystals." Final report. October 1986-October 1987. Alexandria, VA: Institute for Defense Analyses, March 1988. 65p.

Abstract: *We develop an analytical model describing energy transfer between microscopically correlated donor-acceptor pairs in solid-state laser materials. We re-examine experimental data for several laser systems; host properties promoting enhanced non-radiative energy transfer are discussed. The results of this more general model are compared to the standard Foerster-Dexter approach of randomly placed donors and acceptors. This work is of interest to controlling thermal gradients, achieving new laser frequencies, and improving laser efficiency.*

REPORT NUMBER: IDA-M-405
ACCESSION NUMBER: AD-A194 358

Rule, D.W. "Beam-Density Effect on Energy Loss of a Relativistic Charged Particle Beam." Final report for FY83. Silver Spring, MD: Naval Surface Weapons Center, September 1983. 39p.

Abstract: *Starting from the expression for the cooperative ionization energy loss by a pair of relativistic particles, a formula is derived for the beam-density effect on ionization energy loss for a finite length beam with a Gaussian radial profile. As an example, this formula is evaluated for a 50 MeV, 10 KA electron pulse of one-meter length interacting with weakly ionized nitrogen. In this case a large beam-density effect on energy loss was obtained and its dependence on the ionization state of the medium was demonstrated. The relationship of this formulation of energy loss with previous single-particle and beam-plasma loss concepts is discussed.*

REPORT NUMBER: NSWC-TR-83-348
ACCESSION NUMBER: AD-A139 051

Russell, William C., Paul J. Ikeda and Robert G. Vos. "Methodology for Analysis and Simulation of Large Multidisciplinary Problems." Seattle, WA: Boeing Aerospace Co., 15 December 1989. 10p. In: Jet Propulsion Laboratory, California Inst. of Tech., Proceedings of the 3rd Annual Conference on Aerospace Computational Control, Volume 2, p. 538-547.

Abstract: *The Integrated Structural Modeling (ISM) program is being developed for the Air Force Weapons Laboratory and will be available for Air Force work. Its goal is to provide a design, analysis, and simulation tool intended primarily for directed energy weapons (DEW), kinetic energy weapons (KEW), and surveillance applications. The code is designed to run on DEC (VMS and UNIX), IRIS, Alliant, and Cray hosts. Several technical disciplines are included in ISM, namely structures, controls, optics, thermal, and dynamics. Four topics from the broad ISM goal are discussed. The first is project configuration management and includes two major areas: the software and database arrangement and the system model control. The second is*

interdisciplinary data transfer and refers to exchange of data between various disciplines such as structures and thermal. Third is a discussion of the integration of component models into one system model, i.e., multiple discipline model synthesis. Last is a presentation of work on a distributed processing computing environment.

ACCESSION NUMBER: N90-230406

Sailor, W.C. and J. W. Davidson. “Radiological Shielding Calculations for an Airborne Free-Electron Laser.” Los Alamos National Laboratory, NM. 1991. 6p. In: Meeting on New Horizons in Radiation Protection and Shielding, Pasco, WA, 26 April - 1 May 1992.

Abstract: A preliminary set of Monte Carlo calculations of the crew exposure for the proposed airborne free-electron laser have resulted in a lead shielding mass of approximately 6 metric tons. The laser is to be operated only for four training missions per crew per year, with two minutes of laser operation per mission. Beam loss into the cavity walls, the main cause of the crew exposure, is to be kept below 0.01%. The crew will receive about 2.7 R per year, mostly from bremsstrahlung. Neutron dose rates will be negligible by comparison.

REPORT NUMBER: LA-UR-91-4141, CONF-920431-6
ACCESSION NUMBER: DE-92-004577

Salzmann, David and Irith Gilath. “Spallation and Dynamic Fracture as an Effect of Laser Induced Shock-Waves.” Report no. 2. 2 September 1987 – 2 January 1988. Israel Atomic Energy Commission, Yavne Soreq Nuclear Research Centre, 2 January 1988. 8p.

Abstract: The main activities during the last four months of this contract were devoted to a detailed design of the mainstream of the experiments and the purchase of carbon composites targets with appropriate specifications for these experiments. Some preliminary experiments were carried out on 3D C-C targets to get some initial quantitative information about the range of laser intensities required to cause damage to these targets.

ACCESSION NUMBER: AD-A193 513

Sander, O.R. et al. “Commissioning the GTA Accelerator.” Los Alamos National Laboratory, NM. 1992. 6p. In: International LINAC Conference (16th), Ottawa (Canada), 23-28 August 1992.

Abstract: The Ground Test Accelerator (GTA) is supported by the Strategic Defense command as part of their Neutral Particle Beam (NPB) program. Neutral particles have the advantage that in space they are unaffected by the earth's magnetic field and travel in straight lines unless they enter the earth's atmosphere and become charged by stripping. Heavy particles are difficult to stop and can probe the interior of space vehicles; hence, NPB can function as a discriminator between warheads and decoys. We are using GTA to resolve the physics and engineering issues related to accelerating, focusing, and steering a high-brightness, high-current H(sup -) beam and then neutralizing it. Our immediate goal is to produce a 24-MeV, 50mA device with a 2% duty factor.

REPORT NUMBER: LA-UR-92-2716, CONF-92081092-1
ACCESSION NUMBER: DE-92-040234

Sanders, A.A. “Some Trends in Optical Electronic Metrology.” Final Report. Boulder, CO: National Bureau of Standards (NEL), Electromagnetic Technology Division, 1984. 7p. In: Proceedings of the Measurement Science Conference (1984), Long Beach, California, January 19-20, 1984, p. 27-33.

Abstract: The use of optical related devices in high technology is expanding at a dramatic rate. Applications include the expanding use of optical fibers in telecommunications and sensors, lasers in industrial processing and medicine, optical storage devices, directed energy weapons for defensive purposes, non-destructive testing, etc. The Optical Electronics Metrology Group of the National Bureau of Standards has the responsibility for developing the standards, measurement data and methodology infrastructure for supporting much of this expanding technology. The paper reviews some of the ongoing research currently conducted by this group, and some of the perceived important technological applications in this area for the next few years. It discusses Group plans for developing the measurement infrastructure to support these innovations.

ACCESSION NUMBER: PB-8614030

Schmidt, H.J. , J.T. Lineberry and J.N. Chapman. “An Innovative Demonstration of High Power Density in a Compact MHD Generator.” Tennessee University, Space Institute, June 1990. 120p.

Abstract: Magnetohydrodynamic (MHD) energy conversion is a candidate technology for satisfying the pulse power requirements for advanced weapon and discrimination systems for the Strategic Defense Initiative. However, to be competitive with alternative pulse power concepts utilizing nuclear or stored energy schemes the characteristic power per unit weight and volume of the MHD system requires improvement in performance well beyond the levels demonstrated in the past. In this regard, there are two primary performance parameters of concern: the power density and the specific energy. The power density is the ratio of the electrical energy output to the internal volume of the generator channel. The MHD process is a volumetric process and the power density is therefore a direct measure of the compactness of the system. As such, it controls the size and weight of a MHD power generating system for a given power output. The greater the characteristic power density, the smaller and lighter the channel, magnet, combustor and flow train will be. The second parameter, the specific energy, is the ratio of the electrical energy output to consumable energy used for its production. In the case of a chemically driven MHD system, the specific energy is a direct measure of the conversion efficiency from the latent chemical energy to electrical energy. In pulse power MHD systems with short operating durations the specific energy is the controlling parameter for the weight and volume of the stored reactants used to power the system. The two parameters are conceptually interrelated, and for a given mission scenario maximization of both, in general, are required for optimization of the system. However, for short operating durations the power density is the dominant parameter; whereas, for long durations, the specific energy is the dominant parameter.

ACCESSION NUMBER: AD-A338 594

“SDI: Strategic Defense Initiative. A Technical Progress Report.” Washington, DC: Strategic Defense Initiative Organization, April 1987. 57p.

Abstract: Over the past 18 months, significant progress has been made toward establishing the basis for a decision to proceed with full-scale development and deployment of a defense against ballistic missiles. Continuing studies of defense architectural options have provided information on specific issue and technology trade-offs that are key to determining the feasibility of strategic defense concepts. Research in advanced signal processors and cryocooler technology needed to support the space operation of infrared sensor systems has progressed to the point where several technology integrated flight experiments are planned. Kinetic energy weapons technology for ground-launched, rocket-powered interceptors has been developed and is ready for validation testing. Directed energy weapons technologies are less mature than those involved in kinetic energy weapons.

ACCESSION NUMBER: PB-9117117

Seiler, Steven W. “Support to Survivability/Vulnerability Program.” Final report. October 1991-June 1992. Albuquerque, NM: Logicon R and D Associates, April 1993. 18p.

Abstract: This report includes analytic discussion of use of company toroid as magnetized target for compression by solid liner implosion and reports on design and diagnostics for the Phillips Laboratory MARAUDER compact toroid program. Diagnostic work included fielding 20 to 30 magnetic probes with analog fiber optic links and fast photography. The latter required modifications to the MARAUDER triggering system. Design features of factor three conical compression hardware are discussed.

ACCESSION NUMBER: AD-A275 568

“Selected Articles.” National Air Intelligence Center, Wright-Patterson AFB, OH. 20 September 1996. 16p. Translation of **Zhongguo Hangtian** (**Aerospace China**) (China) n.181, p. 37-40, May 1993.

Abstract: At the end of 1990, SDIO canceled comprehensive tests of large model land based free electron laser technologies and turned to the carrying out of average power laser experiments (APLE). The final APLE apparatus realizes electron beam powers of 2 megawatts. Laser average output powers are 100 kilowatts. Wave lengths are approximately 10 microns. APLE projects are jointly funded by the U.S. Army and SDIO. They are cooperatively carried out by the Boeing company and Los Alamos laboratory.

REPORT NUMBER: NAIC-ID (RS) T-0274-96
ACCESSION NUMBER: AD-A316 751

“Selected Articles.” National Air Intelligence Center, Wright-Patterson AFB, OH. 14 January 97. 81p. Translation of **Proceedings of the Symposium on Photoelectric Technology** (China) n. 9 p. 28-35, 107-18, 139-148, 256-265, 266-267. 1995 (CAMA, v. 3, no. 1, 1996).

Abstract: This report includes: (1) The Comparison of The Parallel Scanning And Serial Scanning Scheme of The Optical Mechanical Scanning Infrared Imaging System, (2) The Laser Weapon Development State in Foreign Countries, (3) Space Rendezvous and Docking Navigation Survey Sensor RVD Laser Radar Survey System, (4) Missile's Guidance Head Anti Nuclear Electromagnetic Pulse Reinforcement, and (5) Land Based Guided Missile Anti Thermal Infrared Camouflage Net Research.

REPORT NUMBER: NAIC-ID (RS) T-0397-96
ACCESSION NUMBER: AD-A320 855

Sevat, P. “Design of a TEM Cell EMP Simulator.” Report no. 1084. Ottawa (Ontario), Canada: Defence Research Establishment, June 1991. 115p.

Abstract: Electromagnetic Pulse (EMP) Simulators are designed to simulate the EMP generated by a nuclear weapon and, subsequently, are used to harden equipment against the effects of EMP. This report concerns the design of a small, symmetric, co-axial type of EMP Simulator intended primarily for R and D purposes such as; calibration of sensors, precision measurement, design and testing of transient suppression devices etc. A detailed design is given for a 50 Ohm and 100 Ohm Transverse Electromagnetic cell with a inner volume of l x w x h = 2m x 2m x 1m and a test volume of l x w x h = 2m x 0.3m x 0.4m. The pulse generator and terminating network are integrated into the TEM cell to form a completely shielded structure. In this way no interference from the inside of the cell to the outside, or vis versa, will occur.

REPORT NUMBER: DREO-1084
ACCESSION NUMBER: AD-A246 466

Sevat, P.P.A. “Design of a Bounded Wave EMP (Electromagnetic Pulse) Simulator (Intended as Second Stage Simulator for DREO (Defence Research Establishment Ottawa)).” Report no. 1006. Ottawa (Ontario), Canada: Defence Research Establishment, June 1989. 106p.

Abstract: Electromagnetic Pulse (EMP) simulators are used to simulate the EMP generated by a nuclear weapon and to harden equipment against the effects of EMP. At present, DREO has a 1 m EMP simulator for testing computer terminal size equipment. To develop the R&D capability for testing larger objects, such as a helicopter, a much bigger threat level facility is required. This report concerns the design of a bounded wave EMP simulator suitable for testing large size equipment. Different types of simulators are described and their pros and cons are discussed. A bounded wave parallel plate type simulator is chosen for its efficiency and the least environmental impact. Detailed designs are given for 6 m and 10 m parallel plate type wire grid simulators. Electromagnetics fields inside and outside the simulators are computed. Preliminary specifications for a pulse generator required for the simulator are also given. Finally, the electromagnetic fields radiated from the simulator are computed and discussed.

REPORT NUMBER: DREO-1006
ACCESSION NUMBER: AD-A214 137

Sharma, J. and B.C. Beard. “Effects of Particle Beams on Explosives.” Silver Springs, MD: Naval Surface Warfare Center, December 1991. 25p.

Abstract: For application of particle beams as weapons, it is essential to know the consequences of beam-explosives interactions. In the present work, explosives have been subjected to particle beams of varied parameters below the level of ignition and the consequent chemical and physical changes have been determined. It has been found that in primary explosives (lead azide and lead styphnate) thermal ignition can be achieved regardless of confinement. However, in the case of high explosives such as TNT, HMX, and TATB, confinement is required for thermal ignition. Without confinement other changes such as crystal phase transitions, melt-flow, evaporation, spallation, pyrolysis, fragmentation and chemical decomposition occur. These phenomena could conceivably disable a warhead indirectly by adversely effecting the performance of its explosives.

REPORT NUMBER: NAVSWC-TR-91-682
ACCESSION NUMBER: AD-A256 878

Shelton, F. H. “Satellite System Survivability.” Colorado Springs, CO: Kaman Sciences Corp., 1983. 3 p. From 'AF Academy Proceedings of the 1983 Symposium on Military Space Communications and Operations. USAF Academy, Colorado on 2-4 August 1983, p. 29-31.

Abstract: Present U.S. military capability relies heavily on Earth satellites to maintain connectivity. The essential nature of these satellite systems has made them tempting targets to nuclear attack in wartime. The author reviews U.S. history in high-altitude nuclear device testing and nuclear effects testing on satellites, events in which he directly participated. Physics of the production of nuclear enhanced high-altitude electron belts are reviewed. The author discusses primary effects of the enhanced environment on satellite components. A glimpse into future satellite hardening reveals measures against developing directed energy weapons.

ACCESSION NUMBER: AD-A135 021

Shokair, I.R. “Bolt Beam Propagation Analysis.” Albuquerque, NM: Sandia National Labs., 1991. 6p. In: Charged Particle Beam Conference, Silver Springs, MD, 25-27 June 1991.

Abstract: BOLT (Beam on Laser Technology) is a rocket experiment to demonstrate electron beam propagation on a laser ionized plasma channel across the geomagnetic field in the ion

focused regime (IFR). The beam parameters for BOLT are: beam current I(sub b) = 100 Amps, beam energy of 1--1.5 MeV ((gamma)=3--4), and a Gaussian beam and channel of radii r(sub b) = r(sub c) = 1.5 cm. the N+1 ionization scheme is used to ionize atomic oxygen in the upper atmosphere. This scheme utilizes 130 nm light plus three IR lasers to excite and then ionize atomic oxygen. The limiting factor for the channel strength is the energy of the 130 nm laser, which is assumed to be 1.6 mJ for BOLT. At a fixed laser energy and altitude (fixing the density of atomic oxygen), the range can be varied by adjusting the laser tuning, resulting in a neutralization fraction axial profile of the form: f(z) = f(sub 0) e(sup (minus)z)/R, where R is the range. In this paper we consider the propagation of the BOLT beam and calculate the range of the electron beam taking into account for fact that the erosion rates (magnetic and inductive) vary with beam length as the beam and channel dynamically respond to sausage and hose instabilities.

REPORT NUMBER: SAND-91-2631C, CONF-9106276-5
ACCESSION NUMBER: DE-92-005317

Silk, J.K. "A Program to Study the Detection of Target Hits by Directed Energy Weapons." Arlington, VA: American Science and Engineering, Inc., March 1982. 47p.

Abstract: This is the final report on a study of the detection, using X-ray emission signatures, of target hits by neutral particle beam directed energy weapons. We find that the energy deposition needed for a detectable signature is a small fraction of that required for lethality. This result causes optimism about the feasibility of X-ray hit detection. Two potential obstacles up to detection were considered: the naturally occurring background and absorption by the residual atmosphere. Spectral discrimination can solve the background problem. The emitted spectrum contains characteristic X-rays, especially K-lines. For metallic targets, the background is small at the characteristic wavelength. The background contribution can be suppressed by narrowing the bandpass. Absorption by the residual atmosphere is negligible above 200 km altitude. At lower altitudes, attenuation is unimportant for nickel or steel targets, but significant for materials with longer wavelength K-lines. The ranges of beam/detector parameter values over which detection is possible are presented. The next steps should be implementation studies. Large area detectors with spectral discrimination are needed. Collecting optics using synthetic multilayer structures are a promising approach.

REPORT NUMBER: AFOSR-82-0571-TR
ACCESSION NUMBER: AD-A117 711

Slinker, S.P., R.F. Hubbard and G. Joyce. "Plasma Physics, and Transportation and Use of Positively Charged Particle Beams." Patent Application. Washington, DC: Department of the Navy, Filed 13 December 1991. 17p.

Abstract: The invention pertains to plasma physics, and in particular to and transportation and use of positively charged particle beams. Particle beams of positively charged atoms have potentially a number of useful applications, among which are thin film deposition, semiconductor doping, use as a general laboratory tool, a source of pulsed neutrons (i.e. by impacting a suitable target), shock hardening of materials, advanced military weaponry, and, most interestingly, as the trigger in a nuclear fusion reactor. Unfortunately, a number of these applications require that after the beams are created in particle accelerators, they must travel a considerable distance to their targets.

PAT-APPL-78-01248

Smith, A.C. "Intense Electron Beams for Directed Energy Weapons Research." Livermore, CA: Lawrence Livermore National Laboratory, January 1985. 9p.

Abstract: This report is the script for the film "Intense Electron Beams for Directed Energy Weapons Research."

REPORT NUMBER: UCID-20348
ACCESSION NUMBER: DE-86-002858

Smith, Richard C. et al. “Precision Pointing Experiment.” Final report. 23 February 1989-30 September 1994. Albuquerque, NM: Lockheed Missiles and Space Co. Inc., October 1994. 193p.

Abstract: The objective of the Spice Program was to demonstrate improvement in precision pointing, tracking, and retargeting by integration of active isolation, active and passive structural control, advanced materials, active optics, and adaptive control. Experiments were carried out on a full-size and well- characterized precision test-bed that represented a space laser structure. in the Precision Pointing Experiment, an active control system that combined low authority local rate feedback and high authority global control was designed with the goal of achieving 50:1 attenuation of line-of-sight jitter in the 5- to 500-Hz band. The jitter was due to disturbances input at the base of the structure and at the simulated secondary mirror. A custom suite of optical sensors allowed determination of the line of sight of the structure. Proof mass actuators of unprecedented force and linearity were developed during this and preceding subtasks. A series of tests culminated with the attainment of repeatable attenuation of line-of-sight jitter by 75:1 in the band 5 to 500 Hz with little spillover into unmodeled structural modes or unregulated degrees of freedom. The control system proved to be robust, with gain margin greater than 1.75 demonstrated. Comparison of measure transfer functions with those calculated from the structural model used in the control system design showed that high controller performance does not require unreasonable structural model accuracy.

REPORT NUMBER: PL-TR-94-1014
ACCESSION NUMBER: AD-A291 015

Smith, R. H. “Concepts for LHX (Light Highly Capable Aircraft) Avionics.” Fort Rucker, AL: Army Aviation Center, November 1982. 5p. In: Proceedings Papers of the AFSC (Air Force Systems Command) Avionics Standardization Conference (2nd) Held at Dayton, Ohio on 30 November-2 December 1982. Volume 2, p. 815-819. [N84-31165]

Abstract: LHX is the acronym for a family of light, highly capable aircraft intended for operational use in the airland battle well beyond the year 2000. They will be capable of operation in a wide variety of adverse environments on a very hostile battlefield (lasers and other directed energy weapons will be commonplace). Accordingly, the conceptual designs being considered are very different from today's helicopters (fig. 1). One major thrust is toward automation of crew duties, with a goal of achieving single pilot operation.

ACCESSION NUMBER:AD-A142 777

Sovinec, C.R. and R.E. Peterkin, Jr. “Phase 1B MARAUDER Computer Simulations-Formation of Plasma Torus.” Weapons Lab., Kirkland AFB, NM: Weapons Laboratory, 1990. In: Conference Record - Abstracts. 1990 IEEE International Conference on Plasma Science, Oakland, CA, 21-23 May 1990. p. 167-168.

Abstract: Summary form only given. The MARAUDER (magnetically accelerated rings to achieve ultrahigh directed energy and radiation) program at the US Air Force Weapons Laboratory is a study of magnetically confined plasma toroids that will convert stored electrostatic energy into plasma kinetic energy. The first phase of the experimentation only forms the toroids and does not attempt to compress and accelerate them. Magnetohydrodynamic (MHD) calculations have been performed with the 2-1/2 dimensional code MACH2 in support of this phase. The simulations demonstrate the formation of the torus, including reconnection of the poloidal magnetic field components. Number densities in the toroids are on the order of 10/sup 16/ per cm/sup 3/, and the magnetic induction is on the order of 1 T. A series of calculations shows that only a limited range of discharge energy will produce toroids. Too little energy will not

push the plasma through the initial, injected poloidal field; too much will not allow a good reconnection.

Standler, R.B. “Technology of Fast Spark Gaps.” Final report. October 1987-July 1988. Pennsylvania State University, University Park, Communications and Space Sciences Laboratory, September 1989. 45p.

Abstract: To protect electronic systems from the effects of electromagnetic pulse (EMP) form nuclear weapons and high-power microwave (HPM) weapons, it is desirable to have fast responding protection components. The gas-filled spark gap appears to be an attractive protection component, except that it can be slow to conduct under certain conditions. This report reviews the literature and presents ideas for construction of a spark gap that will conduct in less than one nanosecond. The key concept to making a fast-responding spark gap is to produce a large number of free electrons quickly. Seven different mechanisms for production of free electrons are reviewed, and several that are relevant to miniature spark gaps for protective applications are discussed in detail. These mechanisms include: inclusion of radioactive materials, photoelectric effect, secondary electrode emission from the anode, and field emission from the cathode.

ACCESSION NUMBER: AD-A214 199

“STAR 21, Technology Forecast Assessments. Strategic Technologies for the Army of the Twenty-First Century.” Washington, DC: National Research Council, Commission on Engineering and Technical Systems. 1993. 700p.

Abstract: The Assistant Secretary of the Army for Research, Development and Acquisition (ASA(RDA)) wrote to the Chairman of the Board on Army Science and Technology in March 1988 to request a study under the auspices of the National Research Council. The study's goal would be to assist the Army in improving its ability to incorporate advanced technologies into its weapons, equipment, and doctrine. The time period to be addressed by the study was specified to extend at least 30 years into the future. The three study objectives stated in the request were to (1) identify the advanced technologies most likely to be important to ground warfare in the next century, (2) suggest strategies for developing the full potential of these technologies, and (3) project implications of the technology changes for force structure and strategy. The ASA(RDA) expressed the belief that the expert, independent advice provided by such a study would help the Army in selecting those strategic technologies that offer the greatest opportunity for increasing the effectiveness of forces in the field. The study would also assist the Army in designing current research and development (R and D) strategies to ensure that such advanced technologies do become available for future Army applications.

ACCESSION NUMBER: AD-A275 968

Steffan, C.P. “Fabrication of an Explosive Driven Linear Magnetic Flux Generator.” Livermore, CA: Lawrence Livermore National Laboratory, July 1989. 11p. In: American Electroplaters and Surface Finishers Symposium, Las Vegas, NV, October 1989.

Abstract: Lightweight, high power electrical generators are required for aerospace and defense applications. Single use, linear designs offer high current output from a small package. Electrical current magnifications of the order of 100 to 200 times are expected to be achieved, with higher efficiencies on the horizon. A method of fabricating one of these units, which includes electroforming copper on a precision machined, composite aluminum/epoxy mandrel is described.

REPORT NUMBER: UCRL-101633, CONF-8910296-2
ACCESSION NUMBER: DE-90-002994

Stellingwerf, Robert F, Robert E. Peterkin, Jr., and Donald J. Sullivan. “Beam and Plasma Physics Research.” Final Report. August 1986 – March 1990. Albuquerque, NM: Mission Research Corp., June 1990. 125p.

Abstract: Analysis was performed in high power microwave computations and theory and high energy plasma computations and theory. The HPM computations concentrated on generation, sources and propagation. Major codes used were the particle-in-cell codes SOS and ISIS. Topics studied were sources and antennas, propagation, relativistic klystron amplifiers, virtual cathode oscillators, magnetically insulated transmission lines, transvertrons and vircator phase/frequency locking. High energy plasmas were analyzed with MACH2, an implicit continuous Eulerian, arbitrary Lagrangian-Eulerian nonideal magnetohydrodynamic code. MACH2 modeled a variety of high energy plasmas including plasma flow switches, imploding liners and plasmas, compact toroids, magnetic reconnection and plasma guns. A smooth particle hydrodynamics code was developed to model various conditions, including shock heating, explosions and implosions. An optical multichannel analyzer was also provided to analyze plasma emission line spectra.

ACCESSION NUMBER: AD-A224 452

Steverding, B. and J.S. Browning. “Significance of Single Particle Effects in Neutral Beam Weapon Lethality.” Washington, DC: Defense Nuclear Agency, 1985. 2p. In: Heart Conference, Monterey, CA, 25 July 1985.

Abstract: This paper provides a rationale for assessing the response of microelectronics to single event effects caused by directed energy weapons utilizing beams of neutral particles. The current understanding of single particle vulnerabilities is summarized, and an extrapolation of these vulnerabilities outside of the experimental domain is presented.

REPORT NUMBER: SAND-85-1139C, CONF-85-756-2
ACCESSION NUMBER: DE-85-012031

Strakovskiy, Leonid et al. “Laser Ignition of Propellants and Explosives.” Aberdeen Proving Ground, MD: Army Research Laboratory, June 1998. 81p.

Abstract: Laser and radiative ignition of 24 solid propellants and explosives was analyzed. The effect of ignition criterion used to calculate ignition delays from models was evaluated. Values for the optical parameters reflection, R(lambda) and absorption, k(lambda) coefficients at wavelengths 0.36-1, 1.06 and 10.6 microns were summarized. Effects of in-depth absorption and vaporization were considered. Methods for determining the relation of ignition delays for conductive heating (R(lambda) = 1, k(lambda) = infinity) and radiative heating at various wavelengths were developed. Methods for deriving kinetic parameters for the ignition and vaporization mechanisms were developed. Changes in the ignition mechanism at high radiative power/flux are discussed. A summary of the minimum flux levels needed for ignition and the Arrhenius kinetic parameters determined from ignition delay measurements with several energetic materials is presented.

REPORT NUMBER: ARL-TR-1699
ACCESSION NUMBER: AD-A348 616

“Strategic Defense Initiative Organization Data Center Overview.” Arlington, VA: Photon Research Associates, Inc., January 25, 1991. 25p.

Abstract: The Strategic Defense Initiative Organization (SDIO) program experiments generate significant quantities of science and engineering data. To protect the large investment made in collecting the resulting test and measurement data SDIO has established data centers to manage the storage, access, and distribution of this information. These data centers provide experimenters, developers, scientists, and analysts access to databases of reduced, verified and validated experiment data at institutions with the expertise to support their data requirements. The SDIO science and technology data centers (STDC's) are located at existing DoD centers of

expertise relating to science phenomenology and technology. Three phenomenology data centers handle information such as earth and space backgrounds, missile plume signatures, and reentry vehicle information. Two engineering and technology data centers manage information about kinetic energy weapons and directed energy weapons. A sixth data center, the National Test Facility (NTF), serves as a coordinating data center for technical issues and is the center of the National Test Bed (NTB). To assure that the data centers adequately serve the needs of the SDIO community, the User Products Information Group (UPIG) coordinates activities among the data centers and the Data Center Standards Committee (DCSC).

ACCESSION NUMBER: AD-A338 091

Strickland, Brian et al. "Free Electron Laser Technology Status in the United States." Summary Report 1979-1995. Huntsville, AL: Army Space and Strategic Defense Command, 25 October 1995. 20p.

Abstract: The purpose of this paper is to provide an overview of the Free Electron Laser weapons development program from its beginnings in 1979 to the present. A historical overview of the programmatics will be provided but the primary emphasis will be the technical accomplishments made during this period.

ACCESSION NUMBER: AD-A301 128

"Survivability and Effectiveness of Near-Term Strategic Defense." Los Alamos National Laboratory, NM. January 1990. 23p.

Abstract: This paper examines the survivability and effectiveness of space-based defensive missiles --- a rapidly evolving technology --- on a quantified basis. The effectiveness and costs of attack and defense are estimated and cost-exchange ratios are calculated in differing configurations. Various moves and countermoves are compared. Low-weight, self-reliant defensive missiles are found to be most effective. The advantages of the development of decoys for defensive missiles and of a small pilot deployment are discussed.

REPORT NUMBER: LA-11345-MS
ACCESSION NUMBER: DE-90-005805

"Survivability Enhancement Study for C Sup 3 I/BM (Communications, Command, Control and Intelligence/Battle Management) Ground Segments." Final Report. Germantown, MD: Fairchild Space Co., 30 October 1986. 181p.

Abstract: This study involves a concept developed by the Fairchild Space Company which is directly applicable to the Strategic Defense Initiative (SDI) Program as well as other national security programs requiring reliable, secure and survivable telecommunications systems. The overall objective of this study program was to determine the feasibility of combining and integrating long-lived, compact, autonomous isotope power sources with fiber optic and other types of ground segments of the SDI communications, command, control and intelligence/battle management (C sup 3 I/BM) system in order to significantly enhance the survivability of those critical systems, especially against the potential threats of electromagnetic pulse(s) (EMP) resulting from high altitude nuclear weapon explosion(s).

ACCESSION NUMBER: DE-88-011554

Swallom, Daniel W. "Nuclear Reactor Magnetohydrodynamic Power Generator for Directed Energy Weapons." Avco-Everett Research Laboratory, January 1987. 4p. In: New Mexico University Transactions of the Fourth symposium on Space Nuclear Power systems, p. 351-354. [**N88-24254**]

Abstract: The SDI electrical power requirements for directed energy weapons (DEW) may range from tens of megawatts to over hundreds of megawatts. For this application, where the power requirement is continuous for a period to time ranging from tens to hundreds or thousands of seconds, nuclear magnetohydrodynamic (MHD) power generation provides an attractive

method for producing the required power levels. The MHD power system offers the advantages of simplicity of operation because of no moving or rotational parts; no upper limit on gas inlet temperature, which is a restriction in the case of rotating machinery; an upper limit on current output, which prevents the output current from exceeding twice the nominal current; and favorable scaling to larger since systems.

ACCESSION NUMBER: N88-24336

Swenson, D.A. "RFQ Lens for LEBT Applications." Albuquerque, NM: Science Applications International Corp., 31 August 1990. 62p.

Abstract: The U.S. Army Strategic Defense Command (USASDC) solicited proposals for new and innovative particle beam technologies which are relevant to the Neutral Particle Beam (NPB) Program. Since high brightness beams are required for NPB and beam emittance, in large part, is determined by the ion source and low energy matching section, innovations to improve the quality or efficiency of the low energy beam transport (LEBT) are important. Some preliminary studies on radio frequency quadruple (RFQ) lenses indicated that such lenses could be developed with improved capabilities for preparing ion beams for injection into RFQ linacs. These improved capabilities derive from the fact that the focusing effect is inversely proportional to the square of the frequency so stronger focusing can be achieved if the frequency in the RFQ lens is less than that of the RFQ linac. The goal of this project is to design, build, and test an RFQ lens that demonstrates the possibility of decoupling the phase and frequency of the RFQ lens from that of the RFQ linac into which it is focusing ions. The design of the lens was based on two-dimensional beam dynamics and RF cavity geometry analyses performed with the TRACE and SUPERFISH codes, respectively. The lens was then fabricated by a combination of SAIC and subcontracted machine shops. After fabrication, the lens was assembled for verification of resonant frequency, mode separation, tuning, and power conditioning, prior to beam tests.

REPORT NUMBER: SAOC-90/1322
ACCESSION NUMBER: AD-A227 606

Symon, K. "More Thoughts on the Aladdin Experiments - Experiment Set 2." Argonne National Laboratory, IL. October 1988. 18p.

Abstract: It turns out that the theorem of corresponding motions is true only if we restrict the equations of motion to linear and sextuple terms. It is not necessary to work in a regime where the theorem holds, but it has two big advantages. It allows an easy check (see if the theorem holds) on whether there are important terms we are not keeping in the analysis. It also means we can survey the entire neighborhood of the resonance intersection by surveying a semicircle around the intersection. I will assume that we choose the intersection V(sub x) = 7 1/6, V(sub z) = 7 1/3 as suggested in Ref. 1, and that we maintain the validity of the theorem of corresponding motions.

REPORT NUMBER: LS-107-RE (ANL)
ACCESSION NUMBER: DE-96-015130

Tanzman, E.A. "Controlling Weapons of Mass Destruction Through the Rule of Law." Argonne National Laboratory, IL. 8 August 1995. 8p. 1995 Annual Meeting of the American Bar Association, Chicago, IL, 8 August 1995.

Abstract: Many who speak of the end of the Cold War emphasize the improvement in international relations when they speak of the momentous consequences of this event. According to this image, the half century since Trinity has been a period of sparse international communication during which the Eastern and Western blocs hibernated in their isolated dens of security alliances. The emphasis in the phrase "Cold War" was on the word "cold," and relations with the former Communist regimes are now "warm" by comparison. It is equally valid to consider what has happened to the word "was' in this highly descriptive phrase. While meaningful international dialogue was in a state of relative lethargy during much of the last fifty years, the

military establishments of the Great Powers were actively engaged in using as much force as possible in their efforts to control world affairs, short of triggering a nuclear holocaust. Out of these military postures a tense peace ironically emerged, but the terms by which decisions were made about controlling weapons of mass destruction (i.e., nuclear, chemical, and biological weapons) were the terms of war. The thesis of this paper is that the end of the Cold War marks a shift away from reliance on military might toward an international commitment to controlling weapons, of mass destruction through the "rule of law." Rawls wrote that "legal system is a coercive order of public rules addressed to rational persons for the purpose of regulating their conduct and providing the framework for social cooperation. The regular and impartial administration of public rules, becomes the rule of law when applied to the legal system. "In particular, Rawls identifies as part of this system of public rules those laws that aim to prevent free riders on the economic system and those that aim to correct such externalities as environmental pollution..."

REPORT NUMBER: ANL-DIS/CP-87363, CONF-9508209-1
ACCESSION NUMBER: DE-96-004292

Tavis, Michael T., Scott W. Levinson and Kathryn M. Parker. "Implications of Cloud Obscuration on Ground-Based Laser Systems for Strategic Defense." El Segundo, CA: Aerospace Corp., 12 March 1990. 26p.

Abstract: *The evolution and the current status of the Strategic Defense System Phase II ground-Based Laser (GBL) System Concept is reviewed in this report. In particular, the impact of clouds on system configuration and site selection is discussed. By using current models of correlated probabilities of cloud-free line of sight and cloud-free arc (CFLOS4D and CFARC) for several ground stations with cloud realizations provided by the Boehm Saw Tooth generator, we have determined the number of ground sites required to achieve various levels of desired system weather availability. We briefly describe potential improvements in the models and discuss the necessity for using the Whole Sky Imager results now being generated to validate these models with empirical data, thereby lending further credibility of GBL System Concepts.*

ACCESSION NUMBER: AD-A220 492

Thompson, J.R. et al. "Beam Handling and Emittance Control." Technical Report. 1 September 1986 – 28 February 1988. Austin TX: Austin Research Associates, 15 July 1988. 65p.

Abstract: *This report reviews the results of calculations which concern techniques of beam handling and emittance control for high current beams in advanced accelerators. Beam quality requirements for acceptable performance of beam driven free electron laser devices for SDI missions are examined. The beam quality achievable in high current, space-charge-limited diodes is reviewed and found to be potentially high. Emittance growth during gas-focused transport due to streaming instabilities between beam electrons and gas ions is briefly examined, and estimated to be modest. The principal threat to beam quality degradation is estimated to occur during the lengthy process of acceleration and transport past protuberances, constrictions, or discontinuities in the waveguide wall, or during beam aperturing. A Hamiltonian-theoretic analysis of emittance growth during high current electron beam transport, coupled with an envelop equation analysis of the induced transverse beam oscillations, is applied to develop scaling laws for the emittance growth suffered during such events as beam acceleration, propagation past irises or constrictions in the waveguide wall, beam aperturing and axial variation on the magnetic guide field strength. Criteria area developed for preventing excessive emittance growth by avoiding abrupt axial variations and providing sufficiently strong focusing forces. Designed variations in the waveguide wall shape and in the strength of the magnetic guide field may be introduced to greatly reduce emittance growth during such events as beam acceleration.*

REPORT NUMBER: I-ARA-88-U-24
ACCESSION NUMBER: AD-A196 789

Ting, A et al. “Extreme Broadening of Stimulated Raman Scattered Light From High Intensity Laser Plasma Interactions.” Interim Report. Washington, DC: Naval Research Laboratory, 2 May 1995. 15p.

Abstract: High intensity picosecond laser plasma interaction experiments were performed to examine nonlinear scattering mechanisms in field ionized underdense plasmas. Broad and oscillatory spectra were observed for the forward scattered light. The Raman backscattered spectrum showed an extremely broad, supercontinuum like nature, extending from 450 nm to greater than 1200 nm at incident laser intensities of 2 X 10 (exp 18) W/sq cm. Narrow and large amplitude modulations in the spectrum of the backscattered radiation were measured and are attributed to scattering from ion waves.

REPORT NUMBER: NRL/MR/6790-95-7667
ACCESSION NUMBER: AD-A294 165

Tobin, M.T., M.S. Singh and W.R. Meier. “Laboratory Microfusion Facility - Neutronics and Radiological Safety Analysis.” Livermore, CA: Lawrence Livermore National Laboratory, 30 September 1989. 7p. In: 13th International Symposium on Fusion Engineering, Knoxville, TN, USA, 2-6 October 1989.

Abstract: The primary goal of the Laboratory Microfusion Facility (LMF) is to conduct some 1400 target experiments over a five-year period to demonstrate high gain in the laboratory. Projected yields for these experiments range from < 10 MJ to 1000 MJ. High gain experiments are expected to be conducted once per week. After high gain has been achieved, target yields above 100 MJ will be used to conduct weapons physics and weapons effects experiments. In addition, experiments will be conducted to assess the viability of inertial fusion of electric power production space propulsion and space power. This will extend the facility lifetime to as much as 30 years. We have set two design goals that minimize effect of radiation hazards on the operation of the facility. The first is that LMF workers will have access to the diagnostic platforms outside the target chamber within 24 hours after a high-yield shot. This is necessary for retrieving data and preparing for the next experiment. Although it is plausible that routine interior chamber operations may be done remotely, workers may occasionally require access to the inside of the chamber for special tasks. Therefore, the second design goal is that workers can safely enter the chamber for a short time 7 days after a high-yield experiment. We have previously reported many aspects of radiological safety concerning the LME. Here we report further work covering beam tube activation, final optics activation, neutron heating of a diagnostic, electromagnetic pulse (EMP) generation, radiation shielding and tritium recovery/disposal issues.

REPORT NUMBER: UCRL-101148, CONF-8910078-1
ACCESSION NUMBER: DE-90-002787

Todd, A.M.M. W.B. Colson, and G.R. Neil. “Megawatt-Class Free Electron Laser Concept for Shipboard Self-Defense.” Princeton, NJ: Northrop Grumman, 1997. In: Free-Electron Laser Challenges, San Jose, CA, 13-14 February 1997. Proceedings of the SPIE - The International Society for Optical Engineering, vol. 2988, p. 176-184.

Abstract: An efficient MW-class free electron laser (FEL) directed energy weapon (DEW) system holds promise for satisfying shipboard self-defense (SSD) requirements on future generations of Navy vessels because of the potential for high-power operation and the accessibility to all IR wavelengths. In order to meet shipboard packaging and prime power constraints, the power efficiency and high real-estate gradient achievable in a FEL driven by a superconducting RF accelerator is attractive. Configuration options and the key development issues for such a system are described.

Tolk, Norman H. and Richard F. Haglund. “Surface Reactions in the Space Environment.” Final report. 1 October 1986-30 September 1989. Nashville, TN: Vanderbilt Univ., Dept. of Physics and Astronomy, 3 May 1990. 26p.

Abstract: A central goal has been to establish a multidisciplinary Center of Excellence concentrating on the atomic-scale dynamics of surface reactions in the space environment. The major research focus has been the investigation of the ways in which energy deposited by incident atoms, ions, electrons and short wavelength photons is absorbed and localized to produce bond-making and bond-breaking on surfaces and in the near-surface bulk. Knowledge of these microscopic mechanisms provides detailed clues which lead to an understanding of the macroscopic processes which manifest themselves as surface erosion, modification and damage. This research program bears directly on a broad spectrum of questions germane to the long-term operation of platforms in space, including long-term structural, optical and electronic degradation of materials in the ambient near-earth environment, survivability under and hardening against irradiation from directed-energy weapons, vulnerability in disturbed nuclear atmospheres, and discrimination and sensing techniques based on characteristic radiation (glow) signatures. Significant, and in some cases, startling progress has been made in carrying out the research goals of this effort.

REPORT NUMBER: AFOSR-TR-90-0623
ACCESSION NUMBER: AD-A221 767

Tsai, J. “Generalized Lethality Criteria for Beam Weapon Systems.” In: 1988 Annual Summer Computer Simulation Conference, 20th Seattle, WA, July 25-28, 1988. San Diego, CA: Society for Computer Simulation International, 1988. p. 282-287.

Abstract: The lethality criteria which define the interaction between the directed energy systems and the targets have been derived. For high energy laser systems, the lethality criteria are defined in terms of a lethal fluence. For neutral particle beam systems, the lethality criteria can be specified either as lethal charge fluence or as lethal dose. Derivations are all based on an assumed circular profile in the intensity distribution along the radial direction. Three different methods to calculate the lethality criteria are introduced. Lethality criteria and dwell time requirements have been deduced. A relationship between the different lethality concepts has been formulated.

Tunnell, T. “Is Cepstrum Averaging Applicable to Circularly Polarized Electric-Field Data.” Los Alamos, NM: EG and G Energy Measurements Inc., Los Alamos Operations, 25 April 1990. 18p.

Abstract: In FY 1988 a cepstrum-averaging technique was developed to eliminate the ground reflections from charged-particle beam (CPB) electromagnetic pulse (EMP) data. The work was done for the Los Alamos National Laboratory Project DEWPOINT at SST-7. The technique averages the cepstra of horizontally and vertically polarized electric-field data (i.e., linearly polarized electric-field data). This cepstrum-averaging technique was programmed into the FORTRAN codes CEP and CEPSIM. Steve Knox, the principal investigator for Project DEWPOINT, asked the authors to determine if the cepstrum-averaging technique could be applied to circularly polarized electric-field data. The answer is, Yes, but some modifications may be necessary. There are two aspects to this answer that we need to address, namely, the Yes and the modifications. First, regarding the Yes, the technique is applicable to elliptically polarized electric-field data in general: circular polarization is a special case of elliptical polarization. Secondly, regarding the modifications, greater care may be required in computing the phase in the calculation of the complex logarithm. The calculation of the complex logarithm is the most critical step in cepstrum-based analysis. This memorandum documents these findings.

REPORT NUMBER: EGG-106175069, LAO27321946
ACCESSION NUMBER: DE91010824

Turchi, Peter J. “Possible Uses for Phillips Laboratory MHD Generator.” Final report. 1 October 1994 - 30 August 1995. Kirtland AFB, NM: Phillips Laboratory, August 1995. 25p.

Abstract: *There is interest in electromagnetic energy sources for applications to directed energy weapons. Candidates include portable conventional rotating machinery electric generators, magnetic flux compression generators (aka explosive generators, magnetocumulative generators or MCGs) based on explosive action, and magnetohydrodynamic (MHD) generators using chemical energy of explosives or rocket propellants. For portable high energy MHD generators, US technology base appeared to need rescue. The US has received a MHD device in the PAMIR-3U, developed in the former Soviet Union. The present discussion considers uses of this generator for programs on high-power microwave systems and other directed energy concepts. Future applications will be limited by development and funding of specific technical needs. A useful next step would be detailed design of a system to charge high-voltage pulsers. This design should include comparison of single-pulse switching to achieve high-voltage from an inductive storage coil (energy storage option) vs. repetitive switching at low voltage, followed by custom built transformers (direct drive option).*

REPORTNUMBER: PL-TR-85-1095

ACCESSION NUMBER: AD-A317 939

Turman, B.N., M.G. Mazarakis and E.L. Neau. “Fundamentals of High Energy Electron Beam Generation.” Albuquerque, NM: Sandia National Labs., 1992. 13p. In: American Welding Society (AWS) Meeting, Cambridge, MA, 21-23 September 1992.

Abstract: *High energy electron beam accelerator technology has been developed over the past three decades in response to military and energy-related requirements for weapons simulators, directed-energy weapons, and inertially-confined fusion. These applications required high instantaneous power, large beam energy, high accelerated particle energy, and high current. These accelerators are generally referred to as "pulsed power" devices, and are typified by accelerating potential of millions of volts (MV), beam current in thousands of amperes (KA), pulse duration of tens to hundreds of nanoseconds, kilojoules of beam energy, and instantaneous power of gigawatts to teffawatts (10(sup 9) to 10(sup 12) watts). Much of the early development work was directed toward single pulse machines, but recent work has extended these pulsed power devices to continuously repetitive applications. These relativistic beams penetrate deeply into materials, with stopping range on the order of a centimeter. Such high instantaneous power deposited in depth offers possibilities for new material fabrication and processing capabilities that can only now be explored. Fundamental techniques of pulse compression, high voltage requirements, beam generation and transport under space-charge-dominated conditions will be discussed in this paper.*

REPORT NUMBER: SAND-92-1938C, CONF-9209238-1

ACCESSION NUMBER: DE-93-000745

U.S. Department of Defense. Office of the Director of Defense Research and Engineering. “Defense Technology Plan.” Washington, DC: Department of Defense, 1994. 191p.

Abstract: *This technology plan is a compilation of individual plans each covering one of the 19 technology areas comprising everything but basic research that collectively describe the total Department of Defense Science and Technology effort. The primary purpose of this plan is to document the objectives that we are trying to achieve and the science and technology efforts that are being pursed in order to reach these objectives. The plan also identifies the funding that has been allocated for these objectives and the timeframes in which these technologies will be available to be transitioned to new warfighting capabilities. The 19 technology area plans cover:*

aerospace propulsion and power; air and space vehicles; battlespace environments; biomedicine; chemical and biological defense; clothing, textiles, and food; command, control and communications (C3); computing and software; conventional weapons; electronics; electronic warfare and directed energy weapons; environmental quality and civil engineering; human systems interface; manpower, personnel, and training; materials, processes, structures; sensors; ships/watercraft and ground vehicles; manufacturing science and technology; and modeling and simulation.

ACCESSION NUMBER: AD-A285 415

U.S. Department of Defense. Office of the Director of Defense Research and Engineering. "1997 Defense Technology Area Plan." Washington, DC: Department of Defense, 1997. 191p.

Abstract: Not available.

http://www.dtic.mil/dstp/DSTP/97_dtap/dtap.htm

"U.S. Department of Energy Strategic Defense Initiative: New and Innovative Concepts Program." Summary report. Bethesda, MD: TPI, Inc., October 1989. 115p.

Abstract: The Department of Energy's New and Innovative Concepts (N & IC) Program was established in FY1985 as part of the joint program between the Department of Defense and the DOE for strategic defense research and technology development outlined in the FY1984 Memorandum of Agreement between the two agencies. The purpose of the N & IC Program was to elicit revolutionary (rather than evolutionary) concepts, approaches, and ideas from the nation's scientific community. Three public PRDAs and one national-laboratory-directed solicitation were issued seeking participation of universities, large and small businesses, nonprofit organizations, and the national laboratories. The purpose of this report is to present summaries of the forty-two funded state-of-the-art N & IC projects and is intended as an aid in the transfer of the technical results to the scientific community involved in Strategic Defense Initiative (SDI) activities. The potential benefits from this information transfer include the application of N & IC project results to other fields and projects, and the further development of these specific projects by other government and private entities.

REPORT NUMBER: DOE-FF-18204-T-1

ACCESSION NUMBER: DE-90-005006

United States. USAF Scientific Advisory Board. "New World Vistas: Air and Space Power for the 21st Century." Directed Energy Volume. Washington, D.C.: Scientific Advisory Board (Air Force), 1995. 91p.

Abstract: Directed energy weapons, both lasers and microwaves, will have widespread application over the next few decades. A substantial technical data base now allows confident anticipation of weapon applications. Initial airborne weapons to provide boost-phase defense against ballistic missiles and defense of aircraft against missiles will lead the way to space based, or space relayed, weapons. Global presence with weapons capable of destroying or disabling anything that flies as well as most unarmored ground targets will drive a new warfare paradigm. This volume discusses directed energy applications that are most probable as well as most important in three time periods: 10,20, and 30 years. The technologies which should be supported to enable these applications are discussed leading to several conclusions and recommendations. Our intent is that these recommendations are sufficiently detailed to provide rapid definition of technology thrusts in laboratory programs. Reference is also made to a number of classified annexes which cannot be discussed herein.

ACCESSION NUMBER: AD-A309 595

Van Allen, Robert L., James D. Dillow and Gary F. Gurski. “Directed Energy Weapons Tracking and Pointing Space Experiments.” In: Guidance and Control 1987; Proceedings of the Annual Rocky Mountain Guidance and Control Conference, Keystone, CO, January 31-February 4, 1987, San Diego, CA: Univelt Inc, 1987, p. 259-273.

Abstract: A comprehensive set of space experiments is being developed as part of the Strategic Defense Initiative to demonstrate acquisition, tracking, pointing and fire control technologies required for directed energy weapons. The technical requirements for directed energy weapons are discussed and the current approach for resolving technical issues is presented with emphasis placed on issues addressed by analysis, simulation, and ground and space testing. The space experiments include Starlab, the Relay Mirror Experiment, and the Agile Control Experiment.

REPORT NUMBER: AAS Paper 87-031

Van Atta, Richard H., Seymour J. Deitchman and Sidney G. Reed. “DARPA Technical Accomplishments.” Volume 3. An Overall Perspective and Assessment of the Technical Accomplishments of the Defense Advanced Research Projects Agency: 1958-1990. Final report. November 1990-March 1991. Alexandria, VA: Institute for Defense Analyses, July 1991. 95p.

Abstract: IDA has been documenting and assessing the major technical accomplishments and contributions to technological advance made by the Defense Advanced Research Projects Agency (DARPA). Phase I (published as Volume I, P-2192, and Volume II, P-2429) reviewed the origins, evolution, and impact of 49 projects or program areas. This paper (Phase II) focuses on the broader context of DARPA's contributions, including influences external to the agency. Its purpose is to describe the motivation for programs undertaken by DARPA, the intrinsic nature of the research, and the technological advances that emerged. Some programs, such as ballistic missile defense and large acoustic arrays for antisubmarine warfare, were highly successful in their own context, while others, such as computing and computer networks, had wider ramifications for national technological developments. The paper also derives lessons for future DARPA strategic planning and project management.

REPORT NUMBER: IDA-P-2538-VOL-3

ACCESSION NUMBER: AD-A241 680

Van Keuren, E. and J. Knighten. “Implications of the High-Power Microwave Weapons Threat in Electronic Systems Design.” San Diego, CA: Maxwell Laboratory, Inc., 1991. In: IEEE 1991 International Symposium on Electromagnetic Compatibility. EMC Society. Radiating Compatibility from New Jersey, Cherry Hill, NJ, 12-16 August 1991. p. 370-371.

Abstract: High-power microwave (HPM) sources have been under investigation for several years as potential weapons for a variety of combat, sabotage, and terrorist applications. Due to classification restrictions, details of this work are relatively unknown outside the military community and its contractors. A brief, unclassified overview is provided, and introduction to HPM concepts is given. The key point to recognize is the insidious nature of HPM. Due to the gigahertz-band frequencies (4 to 20 GHz) involved, HPM has the capability to penetrate not only radio front-ends, but also the most minute shielding penetrations throughout the equipment. At sufficiently high levels, as discussed, the potential exists for significant damage to devices and circuits. For these reasons, HPM should be of interest to the broad spectrum of EMC

practitioners. Some introductory concepts are presented. A range of topics, including threats, sources, and possible protective techniques are discussed.

Van Keuren, E. and J. Knighten "Use of High Power Microwave Weapons." Cherry Hill, NJ: E. Van Keuren & Associates, 1995. In: Proceedings. 29th Annual 1995 IEEE International Carnahan Conference on Security Technology, Sanderstead, UK, 18-20 October 1995. (New York, NY: IEEE, 1995), p. 482-491.

Abstract: The destructive power of high power microwave (HPM) generators allow them to be used as effective weapons by both law enforcement and criminal organizations. Now, with the desperate need for cash by some developing nations, devices such as relativistic magnetrons, capable of producing multi-megawatts and for use in weapons, have been offered for sale to other nations, groups and individuals. Hence, HPM weapon capability has now become available not only for military use by any nation wishing to invest but by terrorists and other criminal organizations. Similarly this capability is now available for law enforcement activities. For the most part, it is believed that the aforementioned high multi-megawatt power would not be necessary for law enforcement. Powers in the tens to hundred kilowatt range should be adequate, and tailorable sources such as microwave transmitters readily available.

Van Keuren, E., J. Milkenfeld and J. Knighten. "Utilization of High-Power Microwave Sources in Electronic Sabotage and Terrorism." La Jolla, CA: Maxwell Laboratory Inc., 1991. In: Proceedings. 25th Annual 1991 IEEE International Carnahan Conference on Security Technology, Taipei, Taiwan, 1-3 October 1991. (New York, NY: IEEE, 1991), p. 16-20.

Abstract: High-power microwave (HPM) sources have been under investigation for several years as potential weapons for a variety of sabotage, terrorism, counter-security system, and combat applications. The key points to recognize are the insidious nature of HPM and the many areas in which it can impact on security technology. Computers and other equipment can be damaged without user recognition of the cause. HPM has the capability to penetrate not only radio front-ends but also the most minute shielding penetrations throughout the equipment. The potential exists for significant damage to security and other devices and circuits, and even injury to humans. Different HPM threats are described and specific protective measures are outlined.

Verga, Richard L. "Superconducting Magnetic Energy Storage and Other Large-Scale SDI Cryogenic Applications Programs." In: Advances in Cryogenic Engineering, Vol. . 35A – Proceedings of the 1989 Cryogenic Engineering Conference, Los Angeles, CA, July 24-28, 1989. New York, NY: Plenum Press, 1990, p. 555-564.

Abstract: The paper describes the Superconducting Magnetic Energy Storage (SMES) program for terrestrial storage of energy for use in powering ground-based directed energy weapons. Special attention is given to SMES technology for SDI applications, the components of a SMES system, the SMES Engineering Test Model Development Program, and the SMES critical technologies. It is pointed out that SMES has applications other than SDI, such as commercial electric utility industry and space power systems, including hydrogen-cooled cryoconductors, superconducting turboalternators, and high-temperature superconducting power leads.

Verga, Richard L., David Buden and Milan Nikolich. "Five Years of SDIO Power Development Progress." In: IECEC-90: Proceedings of the 25th Intersociety Energy Conversion Engineering Conference, Reno, NV, August 12-17, 1990. Vol. 1. New York, NY: American Institute of Chemical Engineers, 1990, p. 6-12.

Abstract: The Strategic Defense Initiative Organization (SDIO) Power and Power Conditioning Program was established to develop the power technologies needed to enable the envisioned ground-and space-based sensor and weapon systems. In particular, solar power technologies have demonstrated survivability with less weight than present systems. Hardware is being produced for space nuclear power, and lightweight, multimegawatt power source technologies have been demonstrated. SUPER (survivable power module program) is scheduled to fly in FY93, thus validating survivable solar technology applicable to all satellites of military significance for the foreseeable future. The SP-100 ground reactor test is scheduled to begin in FY94 and will provide the basis for a follow-on flight phase. Once operational, SP-100 will provide the nation with the capability to perform high-power military missions heretofore impractical, and will provide a general-purpose power source for a multitude of space exploration missions. The multimegawatt and power conditioning programs will produce the requisite power sources for space-based directed energy weapons. The SMES (superconducting magnetic energy storage) program, which will begin testing of the engineering test model in 1994, will provide a means for powering ground-based lasers with significant spinoff potential to the electric utility industry.

Viecelli, J.A., D. H. Chambers and T.J. Karr. "Computation of Small Scale Velocity Turbulence and its Effect on Optical Scintillations and Stimulated Thermal Rayleigh Scattering." Livermore, CA: Lawrence Livermore National Laboratory, 23 September 1991. 37p.

Abstract: Coherent high-power light beams propagating long distances through turbulent fluids are subject to many kinds of scattering effects; among these are small-scale thermal index instabilities, in which the fluid is heated by the small fraction of light absorbed, amplifying the pre-existing index fluctuations and producing stimulated small-angle Rayleigh scattering. Turbulent velocity fluctuations can inhibit the rate of growth of these instabilities by dispersing the thermal perturbations created by the beam. Methods for computing the turbulent diffusion of the heating perturbations, compatible with fast Fourier transform beam propagation computations, are presented. Propagation calculations of scintillation coherence times and small-scale velocity turbulence thresholds for stimulated thermal Rayleigh scattering are included.

REPORT NUMBER: UCID-21771-Rev1
ACCESSION NUMBER: DE-92-018934

Walker, D.N. et al. "BEAR Program NRL Plasma Physics Instrumentation Measurements."
Los Alamos National Laboratory, NM. 15 November 1989. 101p.

Abstract: The BEAR program was a joint effort to launch, and demonstrate the feasibility of operating, a 1 MeV 10 ma Neutral Particle Beam (NPB) accelerator from a space platform. The accelerator design and manufacture were the responsibility of Los Alamos National Lab (LANL); diagnostics associated with accelerator operation and beam-plasma effects were also to be undertaken by LANL and NRL. Payload Integration and Telemetry was provided by the Air Force Geophysical Lab (AFGL) and Northeastern University (NEU). Beam effects on the local plasma in addition to accelerator produced vehicle effects (e.g., charging) were the responsibility of NRL as outlined herein. The BEAR rocket was launched successfully during the early morning hours of July 13 from White Sands Missile Range, White Sands, N.M. The NRL contribution to this effort included three instrument packages designed to diagnose beam-plasma and vehicle-plasma interactions. The instruments included: (1) Langmuir probe (LP) design consisting of 4 separate sensors; (2) High voltage (HIV) Langmuir Probe designed to monitor vehicle charging through current polarity changes; and (3) Plasma Wave Receive (PWR) designed to characterize the plasma wave emissions covering a broad frequency range from near DC to 50 MHz.

REPORT NUMBER: LA-SUB-94-81
ACCESSION NUMBER: DE-94-012077

Weitz, R.L. “Inverse Compton Conversion.” Final report. Progress report. Albuquerque, NM:
Science Applications International Corp., 19 November 1990. 56p.
Abstract: Inverse Compton conversion has been proposed as an alternative to the bremsstrahlung conversion process as a method of transforming the kinetic energy of an electron beam into a directed beam of photons. An electron beam with incident electron kinetic energy E(sub o) enters a volume of dimension L containing a photon gas, which is characterized by a blackbody temperature E(sub bb) and a density (rho)(sub (gamma)). The electrons will inverse-Compton scatter with individual photons in the photon gas. In this process, energy is transferred to the photons, which are then emitted in the forward direction. The resultant photon beam could be used to deliver a radiation dose to a distant target. This report discusses the theoretical formulation of the problem, presents sample results, and describes the computer code developed to analyze this concept.
REPORT NUMBER: LA-SUB-93-287
ACCESSION NUMBER: DE-93-040567

West, W.J., II. “Strategic Defense Initiative Simulation (SDISIM).” In: 1986 Summer Computer Simulation Conference, Reno, NV, July 28-30, 1986. San Diego, CA: Society for Computer Simulation, 1986, p. 999-1003.
Abstract: Strategic Defense Initiative Simulation (SDISIM) will evaluate multilayer defense effectiveness parametrically as a function of specific combinations of five defense layers and the performance of the systems within a defense layer. SDISIM is able to address leakage analysis, architecture testing, a broad range of systems/subsystem performance and requirements tradeoffs, survivability issues, battle management concepts, and weapon assignment algorithms. All key functional and subsystem models of a multitiered ballistic missile defense system are assembled by an executive program driver into an event-based code that preserves the chronology of all simulated events. SDISIM modeling includes a threat generator, five defense tiers, satellite, probe- and airborne-based optical sensors, kinetic energy and directed energy space-based weapons, battle management command, control, communications, group-based radars, discrimination, ground-based interceptors, and kill assessment.

Westenskow, G.A. “Relativistic Klystron Experimental Results.” Livermore, CA: Lawrence Livermore National Laboratory, 27 October 1988. 7p. In: DARPA/SDIO Services Annual Propagation Review, Newport, RI, 12 September 1988.
Abstract: Relativistic klystrons are being developed as a power source for high-gradient accelerator applications which include compact accelerators, large linear electron-positron colliders, and FEL sources. We have attained 200 MW peak power at 11.4 GHz from a relativistic klystron, and 140 MV longitudinal gradient in a short 1.4-GHz accelerator section. We report here on the design of our first klystrons, the results of our experiments so far, and some of our plans for the near future.
REPORT NUMBER: UCRL-99875, CONF-88091492-7
ACCESSION NUMBER: DE-89-005653

White, R.B., et al. “Sawtooth Stabilization by Energetic Trapped Particles.” Princeton Univ., NJ: Plasma Physics Laboratory, March 1988. 18p.
Abstract: Recent experiments involving high power radio-frequency heating of a tokamak plasma show strong suppression of the sawtooth oscillation. A high energy trapped particle population is shown to have a strong stabilizing effect on the internal resistive kink mode. Numerical calculations are in reasonable agreement with experiment.
ACCESSION NUMBER: DE-88-009343

Wilkenson, W.F. “Theory for Optical Wavelength Control in Short Pulse Free Electron Laser Oscillators.” Monterey, CA: Naval Postgraduate School, June 1993. 110p.

Abstract: The future safety of the U.S. Navy warship depends on the development of a directed energy self-defense system to keep pace with the ever-improving technology of anti-ship missiles. Two candidates are reviewed. The free electron laser (FEL) has the most advantages, but a chemical laser proposed by TRW is ready for installation on existing ships. Initial testing of issues related to directed energy use at sea can be conducted with the chemical laser. When the technology of the FEL matures, it can replace the chemical laser to provide the best possible defense in the shortest period of time. Continuous tunability is a key advantage of the FEL over the conventional laser. But since the output wavelength is dependent on electron energy. It is subject to random fluctuations originating from the beam source. At the Stanford University Superconducting (SCA) Free Electron Laser (FEL) Facility, the effects are minimized through negative feedback by changing the input electron energy proportional to the observed wavelength drift. The process is simulated by modifying a short pulse FEL numerical program to allow the resonant wavelength to vary over many passes. The physical effects behind optical wavelength control are explained. A theory for the preferential nature of the FEL to follow the resonant wavelength from longer to shorter wavelengths is presented. Finally, the response of the FEL to a rapidly changing resonant wavelength is displayed as a transfer function for the system.

ACCESSION NUMBER AD-A271 706

Wilkinson, Charles K. “Orbit Synthesis For Target Satellites.” In: Astrodynamics 1989; Proceedings of the AAS/AIAA Astrodynamics Conference, Stowe, VT, August 7-10, 1989. Part 1. San Diego, CA: Univelt, Inc., 1990, p. 671-695.

Abstract: The purpose of the study is to illustrate the orbit synthesis process for a hypothetical test of a direct-ascent-based kinetic energy weapons (KEW) against an instrumented test cheicle. Test arena and communications considerations for a ground-based directed energy weapon and a direct-ascent-based KEW are outlined, along with launch vehicle constraints, algorithms for off-nominal orbits, and thermal-control and orbit lifetime considerations. Focus is placed on altitude and illumination cycles, general-test and detailed-test constraints, and methodologies for assessing orbit performance. The orbit inclination, test window concept, selection of apogee altitude, orbit inclination, perigee altitude, launch window, and the effect of the launch date.

REPORT NUMBER: AAS Paper 89-410

Wilson, N.G. “Vacuum System Design Considerations of the Los Alamos Accelerator Test Stand (ATS).” Los Alamos National Laboratory, NM. 1986. 4p.

Abstract: The accelerator test stand (ATS), in operation at the Los Alamos National Laboratory, includes a hydrogen ion source, low- and high-energy beam-transport sections, and a 425-MHz radio-frequency quadruple (RFQ) linear accelerator. A 425-MHz drift-tube linac (DTL) and a powered "buncher" matching section have been constructed and will be installed on the ATS. The vacuum systems required for the various sections of the ATS are designed to provide: (1) high gas-load capability, as required in the ion source, and (2) high-vacuum capability in the high-power, radio-frequency accelerator sections (where fast vacuum-system response time is of importance) through the use of distributed, differential pumping as a principal vacuum-system feature. This paper describes properties of accelerator materials, vacuum-systems engineering and analysis, vacuum equipment used, and ATS vacuum-system performance.

REPORT NUMBER: LA-UR-86-1685, CONF-8606291-0
ACCESSION NUMBER: DE-86-011245

Woo, W. and J.S. DeGroot. “Analysis and Computations of Microwave-Atmospheric Interactions.” Final Report. 1 September 1982 – 31 August 1983. California University Davis, Plasma Research Group, 1 June 1984. 26p.

Abstract: The Plasma Research Group has continued the theoretical investigation of microwave atmospheric interactions, in close coordination with personnel at the Naval Research Laboratory and elsewhere. The basic investigation concerns the propagation and absorption of microwaves above the breakdown threshold in the atmosphere with the self consistent breakdown plasma. Typical hydrodynamic calculations show that an ionization front is rapidly formed which moves toward the microwave source and consequently decouples the microwaves from the original ionization region. By focusing the microwaves or using a reflector, ionization can be confined to localized regions where the microwave strength is high enough to cause breakdown even though the incoming microwaves are below threshold.

REPORT NUMBER: PRG-R-98
ACCESSION NUMBER: AD-A149 666

Worsham, Richard, and John R. Clark. “Fire Control Apparatus for a Laser Weapon.” Patent. Washington, DC: Department of the Air Force, 3 March 1987. 14p.

Abstract: This patent discloses a laser weapon fire control computer apparatus for responding in teal time to the escort/threat scenario that confronts the weapon. The first control computer apparatus compares the threat data with stored predicted scenarios to develop a firing strategy menu which takes into account the fact that the laser energy is instantaneously propagated to the target but requires a substantial amount of time to inflict damage. The fire control computer apparatus utilizes the weapon’s status, dwell time, slew time and fuel limits to yield a weapon pointing sequence and weapon on off time.

PATENT: 4,647,759

Wu, T.T. et al. “Fields and Currents and Charges on Obstacles in a Parallel-Plate Simulator at Selected Frequencies and with Pulse Excitation.” Final report. 2 February 1981-1 May 1983.
Cambridge, MA: Harvard Univ., Gordon McKay Laboratory, August 1983. 56p.

Abstract: This final report summarizes the results of a 2-year study performed at Harvard University to determine the properties of the Harvard model simulator at selected frequencies and under pulse excitation. The continuous-wave (CW) study is completed with measurements at intermediate frequencies; a novel series apron device is developed to improve the performance in this frequency range. The pulse study begins with a theoretical and experimental investigation of the simpler rhombic simulator, and concludes with an investigation of the Harvard parallel-plate simulator. Both the rhombic and the metal-plate simulators exhibit unexpected complications which require further study. Each feature is examined individually and the sources of the many parasitic pulses are determined. Methods for eliminating the undesired pulses are presented, along with a new experimental technique to reduce the systematic interference and a new theory to solve for the current in the time domain.

REPORT NUMBER: AF-WL-TR-83-45
ACCESSION NUMBER: AD-A132 406

Wysocki, F.J. et al. “Progress with Small, High-Magnetic-Field Spheromaks in CTX.” Los Alamos National Laboratory, NM. 1989. 5p. In: US/Japan Workshop on Field-Reversed Configurations and Compact Toroids (11th), Los Alamos, NM (USA), 7-9 November 1989.

Abstract: The current CTX program is directed towards using spheromaks as an energy transfer medium to accelerate metal plates to hypervelocity. In the proposed scheme, the spheromak is

first compressed by accelerating a large plate to moderate velocity (3--5 km/s) with high explosives (HE). Another smaller plate is designed such that it experiences little force until the spheromak is compressed to a size comparable to the small plate. Then the force on the small plate rises quickly, accelerating this plate to high velocity. Present theoretical calculations indicate velocity gain of the small plate over the large plate as high as four, which could produce 20 km/s small plate velocity. In principle, the final velocity is limited only by the sound speed of the spheromak, and in practice, is probably limited by ohmic heating in the plate, the amount of energy that can be delivered to the large compression plate, and the energy dissipated by the spheromak during compression. Taking these effects into account, final velocities in the range 40--100 km/s might be achievable.

REPORT NUMBER: LA-UR-89-3767, CONF-8911130-7
ACCESSION NUMBER: DE-90-003395

Ya-Ping, Zhang. "1993 Technical Progress in Directed-Energy Weapons in the United States."
National Air Intelligence Center, Wright-Patterson AFB, OH. 6 February 1996. 15p. Translation of **Zhongguo Hangtian**, (China) p. 36-39.

Abstract: No abstract available.

REPORT NUMBER: NAIC-ID (RS) T-0628-95
ACCESSION NUMBER: AD-A306 419 [also available via DTIC's Fulltext Technical Reports Internet Site]

Ya-Ping, Zhang. "Review and Prospects of the United States Directed-Energy Weapons Technology Development in 1994." National Air Intelligence Center, Wright-Patterson AFB, OH. June 1996. 11p. Translation of **CAMA, China Astronautics and Missilery Abstracts**, 1995, v. 2, n. 4, p. 41-43.

Abstract: Directed-energy weapons are new-generation weapons developed on the basis of the new concept of replacing conventional bullets with high-energy-density beams. Technically, directed-energy weapons can be divided into three branches, namely: (1) laser weapons, which can destroy or destabilize targets by using electromagnetic radiation energy beams with a wavelength of less than 1 millimeter; (2) radio-frequency weapons, which can destroy or destabilize targets with radiated electromagnetic energy within the radio spectrum range (the wavelength is more than 1 millimeter and radio frequency less than 300 gigahertz); (3) particle beam weapons, which are capable of destroying or destabilizing targets with neutral high-energy atomic particle beams (usually hydrogen, deuterium and tritium) or charged high-energy atomic or subatomic particle beams.

REPORT NUMBER: NAIC-ID (RS) T-0089-96
ACCESSION NUMBER: AD-A310 485 [also available via DTIC's Fulltext Technical Reports Internet Site]

Yee, J.H., W.J. Orvis and L.C. Martin. "Theoretical Modeling of EMP Effects in Semiconductor Junction Devices." Final report. Livermore, CA: Lawrence Livermore National Laboratory, February 1983. 42p.

Abstract: This report discusses various damage mechanisms and their effects on the performance of semiconductor devices, and some of the important theoretical models which are used to describe second breakdown phenomena. The dominant mechanism responsible for the occurrence of second breakdown is probably the thermal excitation of electrons from a device's valence band (thermal mode second breakdown); conclusions from theoretical calculations based on three different approximations seem to support this model. Current mode breakdown, another form of second breakdown, is discussed in terms of the role it plays in determining the shape of the threshold failure power curve. The purpose of this

investigation is, therefore, to assess the existing models and known mechanisms which can cause damage to a p-n junction device in an electromagnetic pulse environment.

REPORT NUMBER: AF-WL-TR-82-91
ACCESSION NUMBER: AD-A125 976

Yeo, Yung K. "Superconductivity." In: Critical Technologies for National Defense. Washington, DC: American Institute for Aeronautics and Astronautics, 1991, p. 319-325.

Abstract: Many potential high-temperature superconductivity (HTS) military applications have been demonstrated by low-temperature superconductivity systems; they encompass high efficiency electric drives for naval vessels, airborne electric generators, energy storage systems for directed-energy weapons, electromechanical launchers, magnetic and electromagnetic shields, and cavity resonators for microwave and mm-wave generation. Further HST applications in militarily relevant fields include EM sensors, IR focal plane arrays, SQUIDs, magnetic gradiometers, high-power sonar sources, and superconducting antennas and inertial navigation systems. The development of SQUID sensors will furnish novel magnetic anomaly detection methods for ASW.

You-Wen, Yau. et al. "Overview of Via Formation Technologies for Ceramic Packaging Manufacturing." In: 1993 Proceedings, 43rd Electronic Components and Technology Conference. Orlando, FL, 1-4 June 1993. p. 155-158.

Abstract: Via hole formation plays an important role in multi-layer electronic packaging fabrication because it provides vertical paths for the packaging interconnection networks. As the packaging wiring density and complexity increases, additional and more stringent demands are put on the via formation technology (e.g. tighter dimensional control, higher via positional accuracy, etc.). Over the years, several via formation technologies have been developed and implemented for manufacturing high performance electronic packages. They range from the traditional mechanical punch to the state-of-the-art directed energy technologies such as laser and electron beam. The primary driving forces for the various via formation technologies are application extension, performance enhancement, cost reduction, and flexibility. In this paper, an-overview of these via forming technologies along with the comparison of their capability and flexibility is given. The focus is on mechanical punching, laser drilling, and electron beam machining.

Young, D. et al. "Experimental Investigation of Relationship Between Nonlinear Field Energy and Emittance Growth." In: Microwave and Particle Beam Sources and Directed Energy Concepts; Proceedings of the Meeting, Los Angeles, CA, January 16-20, 1989. Bellingham, WA: Society of Photo-Optical Instrumentation Engineers, 1989, p. 503-507.

Abstract: This paper reviews the theory of emittance growth of a space-charge-dominated particle beam in a solenoidal focusing field and proposes an experiment to measure the emittance of an electron beam through a magnetic optic. This electron beam can have two different radial charge distributions. The experiment will attempt to show a relationship between the nonlinear field energy and emittance growth.

Young, D. et al. "Experimental Investigation of Relationship Between Nonlinear Field Energy and Emittance Growth." Final report. September 1987-May 1989. Kirtland AFB, NM: Weapons Laboratory, November 1989. 25p.

Abstract: Understanding the phenomena of emittance growth in space-charge-dominated particle beams is important to any application that requires a small final emittance. Many researchers have looked at the process of emittance growth under these conditions. Wangler, et al., uses the idea of nonlinear field energy

to describe emittance growth. In brief, a beam with a nonuniform radial intensity distribution has a potential energy associated with this distribution. As the beam propagates through a solenoidal magnetic field, this potential energy is turned into transverse kinetic energy and manifests itself as emittance growth. The experimental results shows that there is a relationship between the initial intensity profile and the tune ratio to the emittance of charged particle beams in solenoidal focusing fields. The results also agree with the predicted beam intensity profile changes under focusing for peaked and flat beams. This experiment shows that an experiment to verify this theory by using two different beam intensity profiles is feasible. More experimentation in this area is recommended.

REPORT NUMBER: WL-TR-89-31
ACCESSION NUMBER: AD-A215 813

Young, K. David. "Control System Research for Directed Energy Weapons: FY86 Annual Technical Report." Livermore, CA: Lawrence Livermore National Laboratory, CA. October 1986. 539p.

Abstract: *This report describes program progress in numerical algorithms for controls and robust control methods. Nine papers have been separately indexed. Additional information is presented in the report on the following topics: large scale systems control methods; multirate digital control; decentralized/regulated control methods; and mathematical modeling for flexible structures.*

REPORT NUMBER: UCID-20950
ACCESSION NUMBER: DE-87-005206

Young, K. David. "Control System Research for Directed Energy Weapons: FY87 Annual Technical Report." Livermore, CA: Lawrence Livermore National Laboratory, December 1987. 461p.

Abstract: *This paper discusses the different control systems that are being considered to direct directed energy weapons. The control methods discussed are: large scale systems control methods; robust control methods; decentralized/relegated control methods; multirate digital control; decentralized multirate control; and distributed finite element modeling and controls.*

REPORT NUMBER: UCID-20950-87
ACCESSION NUMBER: DE-88-015371

Zhihao, Zhu. "Trends of Microwave Weapon Development." National Air Intelligence Center, Wright-Patterson AFB, OH. 4 January 1996. 15p. Translation of an unidentified Chinese language article, 11p.

Abstract: *Microwave weapons, which depend on electric power and are based on electromagnetic pulse technology, will replace weapon systems that depend on chemical energy. It is estimated that by the twenty-first century, the many directed-energy weapons that will appear, including microwave weapons, will have a profound effect on warfare. Thus, microwave weapon technology should be given sufficient emphasis. This article describes the importance of microwave weapon development, gives a general description of microwave weapons and development trends, and gives some conclusions and suggestions concerning microwave weapons. This article particularly emphasizes the unique role of microwave weapons in countering stealth technology.*

NAIC-ID (RS) T-0632-95
ACCESSION NUMBER: AD-A304 644 [also available via DTIC's Fulltext Technical Reports Internet Site]

Ziolkowski, Richard W. "Focused Electromagnetic Energy Transfer in Space: Investigation of New Electromagnetic Field Representations" Calendar Year

1987 Progress Report to SDIO/IST. Livermore, CA: Lawrence Livermore National Laboratory, January 1988. 144p.

Abstract: New electromagnetic directed energy pulse train (EDEPT) solutions of Maxwell's equations were obtained and studied extensively. One particular solution, the modified power spectrum (MPS) pulse, was selected for more detailed examination for potential SDI applications such as electromagnetic directed energy weapons, completely secure communications, and remote sensing. MPS pulses can be tailored to give directed energy transfer in space in such a manner that theoretically they beat the diffraction limit. Moreover, they represent fields that recover their initial amplitudes along the direction of propagation out to extremely large distances from their initial location. These EDEPT solutions are not physically pathological and can be reconstructed from causal Green's functions. In fact, these fields appear to be launchable from finite aperture antennas.

REPORT NUMBER: UCID-21300
ACCESSION NUMBER: DE-89-009691

Ziolkowski, Richard W. "Localized Transmission of Wave Energy." In: Microwave and Particle Beam Sources and Directed Energy Concepts; Proceedings of the Meeting, Los Angeles, CA, January 16-20, 1989. Bellingham, WA: Society of Photo-Optical Instrumentation Engineers, 1989, vol. 1061, p. 395-402.

Abstract: Exact solutions of the scalar wave and Maxwell's equations that describe localized transmission of wave energy and their representations will be reviewed briefly. These acoustic (ADEPT) and electromagnetic (EDEPT) directed energy pulse train solutions can be optimized so that they are localized near the direction of propagation and their original amplitude is recovered out to extremely large distances from their initial location. Pulses with these very desirable localized transmission characteristics have a number of potential applications in the areas of directed energy weapons, secure communications, and remote sensing. The feasibility of launching an ADEPT from an array of acoustic transducers has been tested experimentally. As will be shown, excellent agreement between theoretical and experimental results was obtained.

Ziska, R.F. "High Energy Lasers: A Primer on Directed Energy Weapons for Space Use."
Monterey, CA: Naval Postgraduate School, September 1984. 86p.

Abstract: The rapid and inevitable commercialization and exploitation of space, which is now gaining increased momentum as the Space Shuttle program settles into a regular monthly schedule, is inescapably increasing our dependence on space-based systems of all kinds. These systems have become vital national interests, the defense of which must be considered whenever realistic war-time scenarios are developed. Consequently, the introduction of weapons into the space environment is an important option, the potential of which must be thoroughly investigated so as not to unwittingly jeopardize critical national assets and ultimately national defense. This thesis is intended to be a semi-technical 'primer' on directed energy laser weapons for utilization in the space environment. The rationale for the selection of space-based laser weapon systems is examined. Additionally, the basic concepts, components, and operations of three of the most promising methods for the generation of high-power laser energy in space are presented.

ACCESSION NUMBER: AD-A151 279

HIGH POWER MICROWAVES

PERIODICALS

"325 CV: 'The Flexible Dutchman.'" **Naval Forces**, 1985, v. 6, no. 1 (Special Supplement), p. 68-73.

"Advances in Mine Warfare." **Naval Forces,** 1990, v. 11, no. 6, p. 49-53.

BOOKS

Abbot, H. L. **Beginnings of Modern Submarine Warfare**. Willets Point, NY: Battalion Press, 1881.

Auer, James E. **The Postwar Rearmament of Japanese Maritime Forces, 1945-71**. New York: Praeger, 1973. 345p.
DKL VA 653 .A9 GENERAL

DOCUMENTS, THESES AND TECHNICAL REPORTS

Although there are a number of very relevant reports issued with distribution limitations (e.g. FOUO or DOD only), due to the public nature of this bibliography, this section includes unclassified/unlimited distribution references only. Abstracts were taken from the DTIC [Defense Technical Information Center] and NTIS [National Technical Information Service] databases and were written by the authors of the documents cited or by the abstracting services from which the citations were generated, not by the authors of this bibliography.

1998 NDIA - 3rd Annual Expeditionary Warfare Conference. Arlington, VA: National Defense Industrial Association, Combat Survivability Division, November 1998. 460p.

ABSTRACT: This document contains the proceedings of the National Defense Industrial Association held on 2-5 Nov 98 in Panama City, Florida. Some topics discussed are mine warfare, amphibious warfare, surface warfare, naval warfare, and amphibious ships.

ACCESSION NUMBER: AD-A359 233

ELETROMAGNETIC PULSE (EMP)

PERIODICALS

Adams, William T. “The Underwater War.” **Ordnance**, November-December 1962, v. 47, p. 317-319.

BOOKS

Abbot, Henry L. **Report Upon Experiments and Investigations to Develop a System of Submarine Mines For Defending the Harbors of the United States**. Professional Papers of the Corps of Engineers, no. 23. Washington, DC: GPO, 1881. 444p. [plus addenda I & II]

DOCUMENTS, THESES AND TECHNICAL REPORTS

Although there are a number of very relevant reports issued with distribution limitations (e.g. FOUO or DOD only), due to the public nature of this bibliography, this section includes unclassified/unlimited distribution references only. Abstracts were taken from the DTIC [Defense Technical Information Center] and NTIS [National Technical Information Service] databases and were written by the authors of the documents cited or by the abstracting services from which the citations were generated, not by the authors of this bibliography.

Ball, Herbert L. **Mine Simulator Planting Rack and Release Mechanism**. Patent. Washington, DC: Department of the Navy, October 1979.
ABSTRACT: This invention pertains to a storage and planting rack for an actuation mine simulator, having a rectangular frame enclosing an open central volume, guiding channels for orienting the mine simulator, and latching and tripping mechanisms for controlling release of the mine simulator. Fins on the mine simulator are guided by diagonally opposed channels into the storage and planting rack. An electro mechanical member causes release of the mine simulator in response to an electric signal, thereby enabling planting crews to precisely control the planting location of each mine simulator.
REPORT NUMBER: PATENT 4,171,664

FREE ELECTRON LASERS

PERIODICALS

“325 CV: ‘The Flexible Dutchman.’” **Naval Forces**, 1985, v. 6, no. 1 (Special Supplement), p. 68-73.

BOOKS

Anderson, Jane, and Gordon Bruce. **Flying, Submarining and Mine Sweeping**. London: Sir J. Causton and Sons, 1916. 36p.

DOCUMENTS, THESES AND TECHNICAL REPORTS

Although there are a number of very relevant reports issued with distribution limitations (e.g. FOUO or DOD only), due to the public nature of this bibliography, this section includes unclassified/unlimited distribution references only. Abstracts were taken from the DTIC [Defense Technical Information Center] and NTIS [National Technical Information Service] databases and were written by the authors of the documents cited or by the abstracting services from which the citations were generated, not by the authors of this bibliography.

Adkins, Arthur A. and David P. Burnette. **Solving the Mine Countermeasures Problem: A Matter of Focus and Priority**. Newport, RI: Naval War College, Center for Naval Warfare Studies, May 1996. 36p.

ABSTRACT: This document reviews mine countermeasure operations and how they impact on current national security and national military strategies as well as service doctrine. It recognizes that shortfalls in dealing with sea mines still exist and recommends where resources should be focused in order tackle the most serious challenges facing future naval operations.

REPORT NUMBER: NWC/CNWS-RR-1-96
ACCESSION NUMBER: AD-A309 750

INTERNET SITES

Airborne Mine Countermeasures Association [AMCA]
URL: http://www.amcm.org/
Includes command histories of the various Helicopter Mine Warfare Squadrons

ACRONYMS AND GLOSSARY

ABL -- Airborne Laser
COIL -- Chemical Oxygen Iodine Lasers
CPB -- Charged Particle Beam
DEW -- Directed Energy Weapons
DEW-V -- Directed Energy Warfare - Vehicle
EMI -- Electromagnetic Interference
EMP -- Electromagnetic Pulse
FEL -- Free Electron Laser
GARDIAN -- General Area Defense Integration Antimissile System
HEL --High Energy Laser
HIRF -- High-Intensity Radio Frequency
HPM -- High Power Microwave
HPRF -- High Power Radio Frequency
LCMS -- Laser Countermeasure System
LLDR -- Lightweight Laser Designator Rangefinder
MIRACL -- Mid-Infrared Advanced Chemical Laser
MODS -- Mobile Ordnance Disrupter System
NLW -- Non-lethal Weapons
NNEMP -- Non-Nuclear Electromagnetic Pulse
SBL -- Space-Based Laser
THEL -- Tactical High-Energy Laser

DTIC Thesaurus: High energy lasers, such as continuous wave, repetitively pulsed, and single pulse, for tactical and strategic applications; Charged and neutral particle beam weapons. Includes energy generators, beam handling and control, target effects and countermeasures.

Directed Energy [DE]: (DOD) An umbrella term covering technologies that relate to the production of a beam of concentrated electromagnetic energy or atomic or subatomic particles. [1]

Directed Energy Device: (DOD) A system using directed energy primarily for a purpose other than as a weapon. Directed-energy devices may produce effects that could allow the device to be used as a weapon against certain threats, for example, laser rangefinders and designators used against sensors that are sensitive to light. [1]

Directed-Energy Protective Measures: (DOD) That division of directed-energy warfare involving actions taken to protect friendly equipment, facilities, and personnel to ensure friendly effective uses of the electromagnetic spectrum that are threatened by hostile directed-energy weapons and devices. [1]

Directed-Energy Warfare: (DOD) Military action involving the use of directed-energy weapons, devices, and countermeasures to either cause direct damage or destruction of enemy equipment, facilities and personnel, or to determine, exploit, reduce, or prevent hostile use of the electromagnetic spectrum through damage, destruction, and disruption. It also includes actions taken to protect friendly equipment, facilities, and personnel and retain friendly use of the electromagnetic spectrum. Also called DEW. [1]

Directed-Energy Weapon [DEW]: (DOD) A system using directed energy primarily as a direct means to damage or destroy enemy equipment, facilities, and personnel. [1]

Electromagnetic Interference [EMI]: (DOD) Any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics/electrical equipment. It can be induced intentionally, as in some forms of electronic warfare, or unintentionally, as a result of spurious emissions and responses, intermodulation products, and the like. [1]

Electromagnetic Pulse [EMP]: (DOD) The electromagnetic radiation from a nuclear explosion caused by Compton-recoil electrons and photoelectrons from photons scattered in the materials of the nuclear device or in a surrounding medium. The resulting electric and magnetic fields may couple with electrical/electronic systems to produce damaging current and voltage surges. May also be caused by nonnuclear means. [1]

Free Electron Lasers [FEL]: High-energy lasers in which the relativistic electron beam energy is converted into optical energy. [2]

High Power Microwave [HPM] Weapons: Energy generated by a conventional electromagnetic apparatus, such as a radar transmitter, or released from a conventional explosion converted into a ratio-frequency weapon which causes the disruption of electronic systems. Usually an ultra-wide ban source focus due to target vulnerability considerations. HPMs can also cause human unconsciousness without permanent maiming by upsetting the neural pathways in the brain and/or death. [3]

Non-Nuclear Electromagnetic Pulse [NNEMP] Weapons: Non-nuclear EMP generating weapons mounted on cruise missiles or unmanned aerial vehicles (UAVs) which would disable enemy tanks and early warning radars would be invaluable. Such weapons when they explode would produce a momentary blast of microwaves powerful enough to disable all but special, radiation-hardened electronic devices. [3]

Particle Beam Weapons [PBW]: Nonnuclear weapons using a stream of high velocity particles or atomic or subatomic particles, excluding simulators for nuclear weapons-provided effects. [2]

Radio Frequency [RF] Weapons: A class of weapons which transmit short, high-powered pulses of electromagnetic radiation over significant ranges. [3]

Thermal Gun: A device that directs energy to produce heat, in concept similar to a microwave oven. [3]

References:

[1] United States. Joint Chiefs of Staff. **DOD Dictionary of Military Terms and Associated Terms**. Joint Publication 1-02. Washington, DC: JCS, 1997. http://www.dtic.mil/doctrine/jel/doddict/

[2] **Defense Technical Information Center Thesaurus**. Ft. Belvoir, VA: Defense Technical Information Center, October 1996.

[3] Bunker, Robert J. (ed.). **Nonlethal Weapons: Terms and References**. INSS Occasional Paper 15. USAF Academy, CO: USAF Institute for National Security Studies, 1997. p. 13.