MISSILE DEFENSE AGENCY (MDA)
SMALL BUSINESS INNOVATION RESEARCH PROGRAM (SBIR)

INTRODUCTION

The MDA SBIR program is implemented, administrated and managed by the MDA Office of Small and Disadvantaged Business Utilization (SADBU). The Acting MDA SBIR Program Manager is Frank Rucky. If you have any questions regarding the administration of the MDA SBIR program please call 1-800-WIN-BMDO. Additional information on the MDA SBIR Program can be found on the MDA SBIR home page at http://www.winbmdo.com/. Information regarding the MDA mission and programs can be found at http://www.acq.osd.mil/bmdo.

For general inquiries or problems with the electronic submission, contact the DoD Help Desk at 1-866-724-7457. For technical questions about the topic, contact the Topic Authors listed under each topic on the website before **1 July 2002.**

PHASE I GUIDELINES

MDA intends for Phase I to be only an examination of the merit of the concept or technology that still involves technical risk, with a cost not exceeding $70,000.

Phase I Proposal Submission

Read the DoD front section of this solicitation for detailed instructions on proposal format and program requirements. When you prepare your proposal, keep in mind that Phase I should address the feasibility of a solution to the topic. MDA accepts Phase I proposals not exceeding $70,000. The technical period of performance for the Phase I should be 6 months. MDA will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, MDA reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

It is mandatory that the ENTIRE technical proposal, DoD Proposal Cover Sheet, Cost Proposal, and the Company Commercialization Report are submitted electronically through the DoD SBIR website at http://www.dodsbir.net/submission. If you have any questions or problems with the electronic submission contact the DoD SBIR Helpdesk at 1-866-724-7457.

This COMPLETE electronic submission includes the submission of the Cover Sheets, Cost Proposal, Company Commercialization Report, the ENTIRE technical proposal and any appendices via the DoD Submission site. The DoD proposal submission site http://www.dodsbir.net/submission will lead you through the process for submitting your technical proposal and all of the sections electronically. Each of these documents are submitted separately through the website. Your proposal must be submitted via the submission site on or before the 3:00 p.m. EST, 14 August 2002 deadline.

Note, however, that a signed original of the Cover Sheet must be submitted by mail to the following address:

Missile Defense Agency
ATTN: ST/SBIR (Rucky)
7100 Defense Pentagon
Washington, DC 20301-7100

Proposals received after the closing date will not be processed. However, while strongly encouraged a signed original of the Cover Sheet will not be required by the submission deadline.

PHASE II GUIDELINES

Phase II is the demonstration of the technology that was found feasible in Phase I. MDA selects awardees for Phase II developments through two competitive processes: a routine competition among Phase I awardees that have been invited to submit Phase II proposals; and a Fast Track competition for Phase I awardees that are able to successfully obtain third party cash partnership funds.

The MDA SBIR PM or one of MDA's executing agents for SBIR contracts will inform Phase I participants of their invitation to submit a Phase II proposal. Fast Track submissions do not require an invitation; see DoD's Fast Track guidelines. Phase II proposals may be submitted for an amount normally not to exceed $750,000. Companies may, however, identify requirements with justification for amounts in excess of $750,000.

Phase II Proposal Submission

If you have been invited to submit a Phase II proposal, please see the MDA SBIR website http://www.winbmdo.com/ for further instructions.

All Phase II proposals must have a complete electronic submission. Complete electronic submission includes the submission of the Cover Sheets, Cost Proposal, Company Commercialization Report, the ENTIRE technical proposal and any appendices via the DoD Submission site. The DoD proposal submission site **http://www.dodsbir.net/submission** will lead you through the process for submitting your technical proposal and all of the sections electronically. Each of these documents are submitted separately through the website. Your proposal must be submitted via the submission site on or before the MDA specified deadline. MDA may also require a hardcopy or your proposal.

MDA FASTTRACK Dates and Requirements:

The Fast Track application must be received by MDA 150 days from the Phase I award start date. Your Phase II Proposal must be submitted within 180 days of the Phase I award start date. Any Fast Track applications or proposals not meeting these dates may be declined. All Fast Track applications and required information must be sent to the MDA SBIR Program Manager at the address listed above, to the designated Contracting Officer's Technical Monitor (the Technical Point of Contact (TPOC)) for the contract, and the appropriate Execution Activity SBIR Program Manager. The information required by MDA, is the same as the information required under the DoD Fast Track described in the front part of this solicitation.

SBIR Phase II Enhancement Policy

To encourage the transition of SBIR research into MDA acquisition programs, MDA has implemented a Phase II Enhancement Policy. Under this policy, MDA will allow extension of an existing Phase II contract for up to one year and will provide additional Phase II funding of up to $250,000, either: 1) as matching funds for non-SBIR MDA funds directed to the Phase II contract; or 2) as transitional funding in anticipation of Phase III, based on a letter of intent to the MDA SBIR PM from a MDA acquisition program that will award a Phase III contract.

PHASE I PROPOSAL SUBMISSION CHECKLIST:

All of the following criteria must be met or your proposal will be REJECTED.

____1. Your technical proposal has been uploaded. The DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and the Cost Proposal have been submitted electronically through the DoD submission site by 3:00 p.m. EST 14 August 2002.

____2. The Phase I proposed cost does not exceed $70,000.

Index of Missile Defense Agency 02.2 SBIR Topics

MDA 02.2 SBIR TOPICS

MDA02-017 **TITLE**: Advanced Algorithm Development

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: MDA/AC

OBJECTIVE: Develop tracking, classification, identification, discrimination, and decision algorithms

Description: Missile defense target tracking, classification, identification, discrimination, and decision making are areas filled with a great deal of uncertainty, based upon lack of specific knowledge about the threat and uncertainty within the sensor measurements. This effort would expand on the state of the art for the development of algorithms for missile defense systems.

PHASE I: Identify a technique which could be used in algorithms for use in missile defense tracking, classification, identification, discrimination, and decision making.

PHASE II: Develop a prototype algorithm (such as a MATLAB version of the algorithm) which can be tested using realistic digital simulations or actual target signatures.

PHASE III: Prepare the algorithm for delivery to the missile defense system developer.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This work could be applied to artificial intelligence applications where decisions are made under uncertainty.

References: None

KEYWORDS: Artificial intelligence; algorithms; tracking; discrimination; identification; decision making

MDA02-018 **TITLE**: Low-Cost Miniature Flight Control System

TECHNOLOGY AREAS: Space Platforms

ACQUISITION PROGRAM: MDA/KB

OBJECTIVE: To develop and demonstrate a low-cost, light-weight, miniature flight control system capable of performing Guidance, Navigation and Control (GN&C) functions for small launch vehicles and interceptors such as the Kinetic Kill Vehicle (KKV).

DESCRIPTION: The Missile Defense Agency (MDA) is interested in developing innovative new concepts for a light-weight, low-cost, miniature flight control system capable of performing GN&C functions for small launch vehicles and interceptors. New technology concepts are being considered that provide high-fidelity GN&C functionality using lightweight COTS components. These systems provide the GN&C necessary to support kinetic kill vehicle requirements that have order-of-magnitude reductions in mass, volume, and cost over existing GN&C systems. The dramatic reductions in mass, volume, and cost of these systems results in major reductions in overall life-cycle cost and enables enhanced weapons system performance for these interceptors. The preferred system would be developed with COTS parts to minimize overall cost and decrease fabrication time. Miniaturization, without adversely affecting system performance is desired. The system must also be designed to withstand launch loads or address how vibration isolation and thermal management will be handled to insure survivability.

PHASE I: Develop a preliminary design and identify potential components. Conduct a preliminary analysis to show system configuration, performance, applicability to launch vehicle and interceptor GN&C requirements, and cost and mass benefits. Develop a program plan that incorporates, but is not limited to, an implementation methodology, launch vehicle and KKV system applicability, proposed program schedule, and estimated costs. Delineate primary technical challenges, and establish risk mitigation strategies while accessing the feasibility and timeline necessary for practical application.

PHASE II: Hardware development and demonstration. Demonstrate the feasibility of the technologies identified in Phase I. Tasks shall include, but not be limited to, a detailed demonstration of key technical parameters, which can be accomplished at a subscale level, although a full-scale prototype demonstration is encouraged if feasible. A detailed performance analysis of the technology demonstration and a commercialization plan is required.

PHASE III: A successful product could be used in support many MDA requirements such as kinetic kill vehicle development, orbital maneuvering capabilities, and other small inexpensive launch vehicles development. Commercially, the system could be used on any number of new, small inexpensive launch vehicles currently in development.

PRIVATE SECTOR COMMERCIAL POTENTIAL : Technologies developed under this SBIR are also applicable to DoD, NASA, and commercial reusable launch vehicles such as the Air Force's Space Maneuvering Vehicle, NASA's X-34 and X-38, Lockheed Martin's X-33, and Kistler's K1.

References:

1. M.K. Martin, D.A. Vause, "New Low Cost Avionics with INS/GPS for a variety of Vehicles", IEEE Aerospace and Electronic Systems Magazine, v.13(#11), Nov 1998.

2. E. GAI, "Guidance Navigation, and Control from Instrumentation to Information Management," Journal of Guidance, Control, and Dynamics, V.19(#1), pp.10-14, Jan-Feb 1996.

KEYWORDS: Low-Cost, Guidance, Flight control, lightweight avionics, avionics, Navigation, GN&C

MDA02-019 **TITLE**: Advanced Nozzle Materials and Concepts for High Mass Flux Boost Motors

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: MDA/KB

OBJECTIVE: Identify non- or low-erosion materials, low-cost fabrication technologies, and nozzle design approaches for very high mass flux axial boost motor (aluminized propellants) nozzles for Boost Phase Intercept Missiles.

DESCRIPTION: Boost Phase Intercept Missiles require extremely high thrust axial motors in order to engage hostile targets in their boost phase. The extremely high thrust axial motors operate at very high pressures for short burn-times (<<10 seconds). The nozzle must survive the very high thermal stresses and exhibit minimal throat erosion in order to maximize intercept missile performance. Since missile diameter is expected to be from 20" to 30", throat diameter is assumed to be approximately 4" to 8" and nozzle fabrication technologies must be scalable to these dimensions.

PHASE 1: Identify appropriate nozzle materials, design approaches, and high risk issues. Conduct critical analyses and/or experiments to confirm viability of proposed material(s), fabrication technique(s), and nozzle design approach(es).

PHASE 2: Fabricate sub-scale nozzle and conduct motor firing demonstration.

PHASE 3: Fabricate full-scale nozzle and conduct motor firing demonstration.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Advanced Boost-Phase nozzle materials and designs could be employed in advanced launch propulsion systems to strengthen US access to space capabilities.

REFERENCES:
1. M. Opeka, "Materials Selection for Advanced Propulsion System Nozzles", Proceedings of the JANNAF Rocket Nozzle Technology Subcommittee Meeting, CPIA, November, 1999.

KEYWORDS: Nozzle materials, nozzle designs, non-eroding materials, low-erosion materials

MDA02-020 **TITLE**: Safe and Flexible Propulsion Technologies for Kinetic Energy Boost Phase Intercept Applications

TECHNOLOGY AREAS: Space Platforms, Weapons

ACQUISITION PROGRAM: MDA/KB

Objective: Enable the development and safe deployment of highly flexible propulsion for Kinetic Energy Boost upper stage, attitude control and Divert and Attitude Control System propulsion. Deployment modes include sea-based, space-based and other deployment modes.

Description (General): Kinetic Energy Boost Phase Interceptor missions are extremely time constrained, necessitating launch of high velocity interceptors without precise targeting information. Consequently, highly flexible upper stage and Divert and Attitude Control System (DACS) propulsion systems are necessary to facilitate appropriate trajectory shaping and impulse management required to achieve a direct hit intercept. Flexibility is critical in these components, since upper stage and DACS propulsion elements are functioned later in the mission when more accurate guidance information is available. Life cycle safety for these propulsion elements is also important, to support shipboard, space-based and non-traditional deployment modes. This SBIR topic solicits proposals for technologies that enable:

· the safe deployment of toxic hypergolic liquid bipropellants onboard U.S. Navy ships for both axial and divert/attitude control system propulsion.

· the development of “green” and safe liquid propellant and propulsion system alternatives with energy density equivalent to Nitrogen Tetroxide (NTO) and Monomethyl Hydrazine (MMH) bipropellants.

· the development of highly flexible solid propulsion system alternatives (>20/1 thrust turndown) or safe liquid propulsion systems that can provide safe, high mass fraction (>0.8) and flexible axial propulsion in a cylindrical volume of approximately 21” Dia x 50” L and with thrust levels of 5000 lbf to 10,000 lbf. Solid propellant candidates should have an energy density equivalent to or greater than an 89% solids loaded HTPB/AP/AL propellant, and safe liquid propellant candidates should have an energy density equivalent to or greater than NTO/MMH bipropellants.

· the development of alternate propulsion concepts that can provide high mass fraction (>0.70) and highly flexible DACS concepts for kill vehicle application, with divert capability of over 10 g’s and on-demand thrust or thrust with a turndown ratio of >20/1. Solid propellant candidates should have an energy density equivalent to or greater than a 4000°F reduced smoke propellant, and safe liquid propellant candidates should have an energy density equivalent to or greater than NTO/MMH bipropellants. Current notional DACS systems fit within a 10” diameter x approximately 13” length. These dimensions are provided for reference purposes and could grow in size.

Note: All propellant candidates must be non-detonable, or be demonstrated to be extremely difficult to detonate.

Phase I: Develop a detailed analytical and experimental database to verify the efficacy and establish the risks of the proposed technology for KE Boost application. Conduct critical experiments to verify the analytical basis and to prove readiness of the technology to transition to Phase II.

Phase II: Design, fabricate and test prototypes of the selected technology under representative conditions, as provided by the Government technical point of contact. The demonstrations should serve as a valid proof-of-concept demonstration that the selected technology has sufficient safety, performance and/or energy management flexibility to support transition to development for KE Boost application.

Phase III: Transition the demonstrated technology into a specific missile application, as identified by the Government KE Boost Team.

Private Sector Commercial Potential: The technologies described in this topic have application to next generation space payload insertion and on-orbit propulsion systems.

References:

1. R. Matlock and CDR. G. May, “KE Boost Industry Introduction Briefing”, 9 January 2002

KEYWORDS: green liquid propellants, safe liquid propellants, safe Liquid Divert and Attitude Control System (LDACS), flexible solid propulsion, flexible Solid Divert and Attitude Control Systems (SDACS), Divert and Attitude Control Systems (DACS), flexible upper stage propulsion, flexible axial propulsion, advanced axial propulsion

MDA02-021 **TITLE**: Innovative Manufacturing Processes

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Materials/Processes, Electronics, Battlespace, Space Platforms, Weapons

ACQUISITION PROGRAM: MDA/MP

Objective: Develop innovative processes that improve manufacturing capabilities, product quality and reliability, reduce unit costs and enhance manufacturing yields and sub-systems and component performance.

Description: MDA is seeking innovative approaches that will allow economically feasible acquisition of new process technologies for components of the ballistic missile defense system. This can range from improvements in fabrication of advanced materials through innovative application of methods and tools to improve manufacturing processes and procedures on current systems and subsystems. MDA is also interested in process technology that facilitates the transition of a product (breadboard, brass board or prototype) from an R&D environment to any manufacturing environment (commercial, defense or both).

Technical areas of interest include, but are not limited to:

· Passive Electro-Optic Sensors and Active Ladar: Infra-red (SWIR, MWIR, LWIR and VLWIR); dual-band and multi band systems; angle-angle range direct detection and coherent ladars and components (transmitters/receivers).

· Radars and RF Components: Advanced GaAs and wideband gap (WBG) high power amplifiers, (UHF through Ka Band); solid state transmitters (IMPATT diodes), thermal management systems, software defined waveform generators/receivers; Advanced Multi-Frequency Generators (AMFG); photonics; MMIC packaging and high-density interconnects; Multi-band frequency date links, multi-band antennas.

· Signal Processing, Data Fusion and Imaging: Advanced Optical Processor (AOP), flow motion sensor, wide instantaneous bandwidth processing of multiple waveforms (Pseudo-Random Noise (PRN) codes, chaotic waveforms).

· Radiation Hardened Electronics: FPA Readouts, FPGAs, ASICs, microprocessors, memory, analogue and digital devices.

· Propulsions: Boosters, divert and attitude control, nozzles, components, high temperature materials.

· Composite Materials and Structures: Polymer matrix and metal matrix graphite and ceramic composites for structures and thermal management systems, missile canisters. integrated thermal /structured aeroshells.

· Batteries: Advanced thermal batteries, lithium and lithium oxyhalide batteries.

Phase I: Demonstrate that a new or innovative process technology can meet MDA needs including, where appropriate, a process technology roadmap for implementing promising approaches for near term insertion into BMD element systems, subsystems, or components.

Phase II: Validate the feasibility of the process technology by demonstrating its use in the fabrication of prototype items for BMD element systems, subsystems, or components. A partnership with the current or potential supplier of BMD element systems, subsystems, or components is highly desirable. Identify any commercial benefit or application opportunities of the innovation.

Phase III: Successful demonstration of a new process technology and near-term application to one or more BMD element systems, subsystems, or components. This demonstration should also verify the potential for enhancement of quality, reliability, performance and reduction of unit cost or total ownership cost of the proposed subject.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Proposals should show how the innovation can benefit commercial business or should show that the innovation has benefits to both commercial and defense manufacturing methods. The projected benefits of the innovation to commercial applications should be clear, whether they reduce cost, improve producibility, or performance of products that utilize the innovation process technology.

References: BMDS Cost Drivers
http://www.winbmdo.com -BMDO/MP presentation at 2001 Defense Manufacturing Conference

KEYWORDS: reliability, reduced costs, yields, performance

MDA02-022 **TITLE**: Innovative Operating Software

TECHNOLOGY AREAS: Air Platform, Information Systems, Ground/Sea Vehicles, Materials/Processes, Sensors, Electronics, Space Platforms, Weapons

ACQUISITION PROGRAM: MDA/MP

Objective: MDA is seeking innovative approaches to software that improves product capabilities, improves product quality and reliability, and reduces the time and cost of transitioning prototypes into production. Of special interest is the application of commercial software approaches, methods, and tools to mitigate problems encountered with legacy software, architectures, and languages, (e.g., ADA).

Description: MDA is seeking innovative approaches that will allow economically feasible acquisition of new software products and adaptation of software to changing situations (e.g., evolving threat). Many missile defense systems use proprietary software in an R&D/laboratory environment, and are subject to expensive, time-consuming custom integration into systems. Also, many legacy DoD systems upgraded for use by MDA employ antiquated software that is difficult to modify and maintain.

Specific technology areas include, but not limited to:

· Fault Tolerant Software: Development of techniques including modification of existing fault tolerant software with application to MDA systems.

· Object-Oriented Software Developments: MDA is interested in conversion of legacy codes into structures that facilitates software upgrades and improves life cycle costs.

· Software Libraries: Many algorithms and software models used for radar, electro-optic imaging, or other MDA applications could be standardized for use across multiple MDA systems.

Phase I: Develop conceptual software, firmware and hardware designs on modifications to existing software that address problem areas addressed above.

Phase II: Validate the feasibility of the software by demonstrating its use in the testing and integration of prototype items for BMD element systems, subsystems, or components. A partnership with the current or potential supplier of BMD element systems, subsystems or components is highly desirable. Identify any commercial benefit or application opportunities of the innovation.

Phase III. Successful demonstration of new open/modular, non-proprietary, operating software. This demonstration should show near term application to one or more BMD element systems, subsystems, or components.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Most innovations in operational software are taking place in the commercial sector. DoD & MDA need infusions of commercially strategic/design tools/middle-ware and software architectures. The projected benefits of the innovation to commercial applications should be clear, whether they reduce cost, improve producibility, or performance or products that utilize the innovation process technology.

References: http://www.winbmdo.com BMDO/MP presentation at 2001 Defense Manufacturing Conference
BMDS Cost Drivers

KEYWORDS: software, quality, reliability

MDA02-023 **TITLE**: Advanced Chemical Iodine Lasers

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: MDA/SL

Objective: Demonstrate innovative concepts relevant to the development of a high-energy chemical iodine laser.

Description: MDA is interested in promoting and conducting innovative research on promising new technologies relevant to the development of high-energy chemical iodine lasers. The most common chemical iodine laser, COIL (Chemical Oxygen Iodine Laser), uses the highly efficient reaction between molecular chlorine and basic hydrogen peroxide (BHP) to generate electronically excited (singlet delta) oxygen. Singlet delta oxygen reacts via electronic energy transfer with atomic iodine to produce a population inversion on the I*(2P1/2) - I(2P3/2) spin-orbit transition. Provided that sufficient gain can be achieved, single line lasing at 1.3 microns is the result of the energy transfer process. Similarly, the All Gas-phase Iodine Laser (AGIL) produces electronically NCl that also reacts with atomic iodine to produce a population inversion.

Unfortunately, traditional COIL devices require the use of highly corrosive and bulky liquid reagents (eg. BHP) and current AGIL concepts use hydrogen azide (HN3) a highly toxic and explosive gas. These features are troublesome for both airborne and space-based applications and the directed energy community is seeking alternative methods for generating singlet delta oxygen and/or NCl.

Potential sources of electronically excited O2 and NCl include electric discharges, alternative chemical mechanisms, optical pumping schemes, or other efficient energy transfer processes. Proposed concepts must be capable of producing high number densities of singlet delta O2, NCl, or another acceptable energy carrier.

Phase I: 1) Define and model a promising chemical iodine laser concept or energy carrier generator. Or 2) investigate issues related to the production, storage, and usage of high densities of hydrogen azide or an alternative source of singlet delta NCl. Identify and investigate the key physical or chemical processes and arrive at a design concept.

Phase II: Continue the effort initiated in Phase I. Design, construct, and carry out the key experiment(s) identified in Phase I. Generate an engineering design for a full scale device. Where appropriate, construct and demonstrate the full-scale device.

Phase III: Construct full-scale lasers appropriate for use by industries interested in high-energy lasers for use in machining and manufacturing.

Private Sector Commercial Potential: Possible applications include nuclear reactor decommissioning, robotic welding, and mining / drilling.

References:
1. Gerald C. Manke II and Gordon D. Hager, "Advanced COIL - Physics, Chemistry, and Uses," J. Mod. Opt., accepted, 2001.
2. Thomas L. Henshaw, Gerald C. Manke II, Timothy J. Madden, Michael R. Berman, and Gordon D. Hager, "A New Energy Transfer Laser at 1.315 microns," Chem. Phys. Lett., Vol. 325, pp. 537- 544, 2000.

KEYWORDS: Chemical lasers; Directed energy weapons; Lasers; Space based lasers; Airborne lasers; COIL; AGIL

MDA02-024 **TITLE**: Phased Array of Solid-State Master Oscillator Power Amplifiers

TECHNOLOGY AREAS: Chemical/Bio Defense, Sensors, Electronics, Weapons

ACQUISITION PROGRAM: MDA/SL

OBJECTIVE: Develop phased array of solid-state master oscillator power amplifiers for directed energy applications

DESCRIPTION: High Energy Lasers are useful for the acquisition, ID and decoy rejection, tracking, and eventually the destruction of distant missiles. In addition they can be used to ID and track other chemical and biological weapons of mass destruction. This topic seeks proposals for demonstration of fundamental concepts, which would enable high-brightness, high-power operation of electrical lasers with a solid state gain medium, using a single master oscillator split to many power amplifiers. A basic requirement for diffraction limited very high power solid state lasers is phase locking of a large number of laser modules. There are existing government programs to lock an array of fiber lasers through a variety of techniques. The phase-locking is yet to be demonstrated to generate diffraction limited beams at high efficiency at power levels exceeding 100 W, and when more than two lasers are concerned.

The topic will seek proposals to demonstrate and characterize (1) near-diffraction-limited phase-locked operation of a phased array solid-state laser system containing a minimum of four laser modules in the near term, and (2) phase-locking of master-oscillator power amplifiers of any solid-state laser construction to achieve near diffraction limited power at 10-kW level in phase III in partnership with industry. Fiber lasers, slab lasers, disk lasers and rotating disk lasers may all be considered for the construction of the individual laser modules. Efficiency of phase-locked operation, number of laser modules, total power and beam quality will be used as metrics.
PHASE I: Select design for prototype approach and define testing methodology for demonstrating feasibility of near-diffraction-limited operation of a phased array solid-state laser system containing a minimum of four laser modules. Phase I should concentrate in generating a design, completing the analysis, and if possible demonstrating the key concept in a prototype. The

metrics for the phase I concept are: (1) detailed design of a phase II experiment to demonstrate phase-locking of four laser modules, at a combined power level of 200 W, and a beam quality of better than 1.1 times diffraction limited, and a wall plug efficiency of the entire system exceeding 20%, (2) conceptual design of a MW class electrical laser with a beam quality of greater than 2 times diffraction limited and wall plug efficiency of the entire system exceeding 10%.
PHASE II: (1) Conduct a concept validation experiment to demonstrate phase-locking of four laser modules, at a combined power level of several hundred watt, and good beam quality (< 1.1) and high wall plug efficiency (>20%), (2) Conduct detailed design of a MW class electrical laser(<2.0).
PHASE III DUAL USE APPLICATIONS: A high-power, high-efficiency electrical laser with diffraction limited beam quality will be capable of adding value to land, air and space based directed energy platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL: High energy electrical lasers are also backbones of material processing in semiconductor, automotive, aircraft and other applications, and also for decommissioning of hazardous manufacturing plants. Phase-locked master-oscillator power amplifiers of any solid-state laser construction at 10-kW level in near diffraction limited beam quality and 10% wall plug efficiency will be a goal in phase III in partnership with automotive, aircraft, semiconductor or aerospace industries.

REFERENCES:
1. David Lyman, Brian Dempsey, and Santanu Basu, " Concept Definition and Technology Roadmap for the Space Based Solid State Fiber Laser (SB SSFL)" in SBL IFX AAS Study - Phase 2 ENGINEERING MEMORANDUM, NOV 2000
2. S. Basu, "Space Based Solid State Fiber Laser", SBL IFX AAS Phase I Final Report, Sept 1999

KEYWORDS: Electric laser, solid state laser, diode, phase locking, directed energy, high energy laser

MDA02-025 **TITLE**: Innovative Thermo-Structural Design Synthesis for Space Based Optical Systems

TECHNOLOGY AREAS: Space Platforms, Weapons

ACQUISITION PROGRAM: MDA/SL

OBJECTIVE: Develop innovative concepts to meet structural, thermal and contamination protection requirements of advanced optical satellites.

DESCRIPTION: The USAF flies a wide range of operational spacecraft that employ optical telescope systems in support of national mission objectives. These satellites must provide rigorous thermal control of the optical components to maintain optimal figure and to protect the optical payload surfaces from contaminants. Past approaches required additional, non-structural shielding and insulation to protect the optics. The objective of this SBIR is to combine the structural strength and stiffness requirements for the Secondary Mirror Support Structure with the contamination protection and thermal management requirements to create a design that is lightweight, affordable, and efficient. The challenge is to combine innovative insulative materials with new structural concepts to develop an optimal design meeting these four mission needs (strength, stiffness, thermal management, and contamination protection). This effort should address the following:
1. Use of innovative composite material structural design and fabrication concepts that:
a. Allow for effective integration of insulative materials
b. Meet structural strength, stiffness, and geometric stability under varying thermal conditions on-orbit.
2. Use of advanced, space-qualified or qualifiable insulative materials.
3. Protection of the optical surfaces under predicted on-orbit particulate contamination exposure assuming Nadir pointing mission scenario.
4. Use of materials qualified for long-term exposure to the space environment
5. Conceptual design approach for an active thermal control system.
PHASE I: As a point of departure to evaluate candidate technologies, assume a cylindrical design with a height of 2.0 m, an inner radius of 2.9 m, and a maximum thickness of 10 cm. The cylinder must support 80 kg (quadrapod and secondary mirror assembly) evenly distributed at 4 points, 90 degrees apart. Assume 8g vertical and 6 g lateral loads for the launch environment. The first mode design goal is > 50 Hz assuming the cylinder is mounted to infinitely rigid base and supporting 80 kg load identified above. The design must also provide access doors at the base of the cylinder over the entire circumference. Temperature stability goal for the primary mirror is 293 + 1 degree Kelvin (20 + 1 degree Celsius).

Determine candidate materials and manufacturing techniques that support this requirement. Identify any "knees" in the curve for manufacturability (length, diameter, thickness, etc.). Establish feasibility of concept based upon evaluation of such issues as mass, strength, stiffness, geometric stability, insulative qualities, and cost. The effort should also address requirements and performance predictions (thermal stability estimate and power consumption) for conceptual thermal control system design. Provide simulation/demonstration of basic concepts.

PHASE II: Finalize design (PDR/CDR) and fabricate the structure and thermal control system. Develop and implement a test plan to verify the required performance. Test data shall be correlated to modeling and simulation predictions.
PHASE III DUAL USE APPLICATIONS: Government systems, in particular Space Based Laser, will directly benefit from the development of this technology. Other systems requiring thermal management will benefit from the optimization of structural and thermal design offered by the development of this technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There is a large commercial market for integrated spacecraft structural-protection-thermal control systems. New commercial optical systems such as IKONOS will directly benefit from this technology.

REFERENCES:
1. Wang, J.Q., Akira Kuraishi, Stephen W. Tsai, Wegner, P.M., "ChamberCore
Testing and Analysis", ICCM13 Conference Proceedings, May 01.
2. P. Wegner, A. Edwards, S. Huybrechts, and T. Meink, "Assessment of Manufacturing Methods for Grid Stiffened Chamber Core Structures", AIAA SDM, April 01

KEYWORDS: Composite Structures, Aerogels, Chamber Core, Multi-layer Insulation (MLI), Design Synthesis, Multi-funtional Structures, thermal control

MDA02-026 **TITLE**: Seeker Guidance and Seeker Discrimination Information Fusion

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: MDA/SM

Objective: Fuse Seeker guidance and seeker discrimination information to optimize guidance divert direction and seeker field-of-view (FOV) management.

Description: Currently, MDA seekers (SMD KW and GMD EKV components) use IR discrimination as part of the final target selection. Usually, IR discrimination improves as the seeker approaches the target cluster and collects more detailed information. Before final target selection, the seeker may have to make divert decisions to keep potential targets in the FOV and kinematically accessible. Guidance decisions and seeker information should be used to optimize divert and field of view management. Ideally, guidance decisions, during IR seeker discrimination, should utilize the current discrimination probabilities ascribed to threat objects. These guidance decisions should include where to aim within a cluster of objects, and how to keep the most likely threat objects accessible for the longest possible discrimination time.

Phase I: Develop an algorithm to fuse seeker guidance and seeker discrimination information to optimize guidance decisions and achieve the highest probability of intercept. Test the algorithm using modeling and simulation to include the guidance decisions as a result of expected time of intercept, the current discrimination probabilities and the remaining available divert.

Phase II: Provide enhancement and efficiencies to improve algorithm performance. Work with a Government designated Lab and industry to integrate the algorithm, developed in Phase I, either into SMD KW or GMD EKV testbed (platform independence).

Phase III: Based on the favorable results of phase II testbed integration and additional improvement the algorithm should be integration ready for a real system.

Commercial Potential: Robotics

References: None

KEYWORDS: Sea Based Mid Course Defense Kinetic Warhead (SMD KW), Ground Based Mid Course Defense Exoatmospheric kill Vehicle (GMD EKV), Guidance, Discrimination

MDA02-027 **TITLE**: Ultra-Wideband RF Discrimination Techniques

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: MDA/SM

Objective: Currently, Sea Based Midcourse Defense Directorate, is developing a suite of S- and X-band radar sensors as part of a future missile defense capability.
Investigate the feasibility of bandwidth interpolation techniques to combine S- and X-band target data into high resolution (ultra-wideband) target data to support near real time multi-band target discrimination. Develop suitable target models and test data to include cone, cylinder and sphere for algorithm evaluation. Investigate target coherent times in both S-and X-band and evaluate the impact on algorithm performance (evaluate time over which target is coherent & non-coherent in both S- and X-band) . A potential approach is to interpolate the frequency response from S- to X-band and show improved target image resolution; however, other approaches can be considered.

Phase I: Develop concept for near-real time RF discrimination approaches that exploit observations and measurements from S- and X-band sensors. Investigate possible approaches for combining generic multi-band sensor data to increase the probability of correctly discriminating ballistic missile threats. Include testing of the proposed algorithms against simple threat objects (cone, cylinder and sphere).

Phase II: Refine concept(s) developed in phase I to allow near real time testing using Government furnished measured radar data. Evaluate the proposed algorithms with intentional and unintentional countermeasures. Analyze test results for system level performance impact. Should the concept be endorsed by industry the government may require additional risk reduction testing in a government approved testbed.

Phase III: At time the technology should be of Technology Readiness Level of 6 for possible transition to weapon system(s).

Commercial Applications: Medical, Structural defects

References: None

KEYWORDS: Wave form, Multi-band RF Discrimination, Narrow-Band, Wideband, Test bed, simple threat model

MDA02-028 **TITLE**: Direct Digitization at Rf

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: MDA/SM

Objective: Design, develop, and test efficient digital and analog signal processing techniques to enable direct digitization of analog signals at RF frequencies (>2 GHz) with wide bandwidth (>400 MHz) and high resolution (85 dB SFDR, 75 dB SNR) and eliminate the need for down conversion mixers.

Description: Overcoming the significant bottleneck in high-speed, high-resolution analog-to-digital conversion, is an enabling technology for the next generation of high performance RF systems (radar, electronic warfare, RF communications) and advanced digital beam forming array systems. The ability to directly digitize RF signals at the antenna element significantly reduces the complexity, size, and cost of multi-element array RF systems.

Phase I: Provide a conceptual design of signal processing techniques for direct digitization of RF signals at the antenna element. Provide a demonstration of the concept design through modeling and simulation.

Phase II: Develop a prototype design to demonstrate proof-of-concept at S-band

Phase III: Develop an engineering model for integration and test in a government approved testbed.

Commercial Potential: These technologies can be applied to many RF applications such as cellular phone industry, commercial airport radar systems, and satellite communications.

KEYWORDS: RF digitization, Analog to Digital conversion, radar, wide bandwidth, wide dynamic range

MDA02-029 **TITLE**: Manufacturability, Producibility, and Reliability of Space Cryogenic Cooling Technology

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: MDA/SS

OBJECTIVE: Develop processes, techniques, and technology to address manufacturability, producibility, and reliability of space cryogenic coolers

DESCRIPTION: Lifetime and reliability are driving concerns for the use of active cryogenic cooling technology in space. Military, commercial, and scientific applications have driven the requirements for the development of long life (10+ years), high reliability cryocoolers for three decades. Although the overall scope of development issues for active refrigeration includes the mechanical cooling unit itself, the power conditioning and control electronics, and the software utilized for cryocooler operation, the current focus and greatest concern is the reliability of the mechanical cryocooler. Recent developments in the state of the art have vastly improved the current generation of cryocooler technology, but significant issues remain and chiefly center around the reliability of the devices utilized for long life mission applications. Quantifying the lifetime and reliability of long life cryocooler technology is elusive. Many of the mechanical refrigerators that have been developed, or are under development, are usually unique or have very low production numbers (1-2 units). Additionally, designs mature and evolve from cooler to cooler to accommodate new improvements or to meet emerging customer specifications. These changes affect the design heritage and any prediction of cryocooler reliability. One large unknown in the useful lifetime prediction for cryocooler performance is the long-term degradation components that are observed only over thousands of hours of operation. Innovative proposals should address design, manufacturing, producibility, and reliability issues for components and complete mechanical cryocoolers. Issues include, but are not limited to, close tolerances, flexing elements, high precision alignment, hermeticity, gaseous contamination, component and system qualification and testing could be addressed with the overall goal of enabling verification of reliable cryocoolers for space applications.

Phase I: Phase I SBIR efforts should concentrate on the development of the fundamental concepts for increased manufacturability, producibility, and reliability of space cryogenic coolers. This could include demonstration of a process or fundamental physical principle in a format that illustrates how this technology can be further developed and utilized in a cryocooler. This effort should include plans to further develop and exploit this technology in Phase II.

Phase II: Phase II SBIR efforts should take the innovation of Phase I and design/develop/construct a breadboard device to demonstrate the innovation. This device may not be optimized to flight levels, but should demonstrate the potential of the prototype device to meet emerging operational specifications. Demonstration of the potential improvements in manufacturability, producibility, and reliability of space cryogenic coolers should be included in the effort. The contractor should keep in mind the goal of commercialization of this innovation for the Phase III effort.

Phase III: Typical MDA military space applications cryogenic coolers relate to infrared sensing, cryogen management, electronics cooling, and superconductivity. Potential Phase III opportunities to transfer this technology to emerging MDA programs include the Advanced Space Based Infrared System and block upgrades to the Space Based Infrared System Low, where a number of cryocoolers are planned to be built and fielded over a short build schedule.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The applications of this technology could potentially be far reaching with large market potential due to the increased reliability and expected reduction in cost for cryogenic coolers. Applications of this technology include NASA, civil, and the commercial sector for space based and airborne uses such as missile tracking, surveillance, astronomy, mapping, weather monitoring, and earth resource monitoring. The need for high reliability cryocoolers for terrestrial applications includes cellular bay station cooling and magnetic resonance imaging. Other potential applications include CMOS (complimentary metal-oxide semiconductor) cooling for workstations and personal computers.

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6. Nellis, G., F. Dolan, W. Swift, and H. Sixsmith, "Reverse Brayton Cooler for NICMOS," Cryocoolers 10, R. G. Ross, Jr., Ed., Plenum Press, New York (1999), pp. 431-438.
7. Ruffin, P. B., and Burgett, S. J., "Recent progress in MEMS technology development for military applications", Proceedings of SPIE - The International Society for Optical Engineering; ISSN: 0277-786X, Mar 2001; v.4334, p.1-12.

KEYWORDS: manufacturability, producibility, reliability, cryocooler, cryogenic, Stirling, Brayton, pulse tube

MDA02-030 **TITLE**: Multistage, High Capacity 35 Kelvin Cryogenic Cooling

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: MDA/SS

OBJECTIVE: Develop enabling cryogenic cooling technology for high capacity, multistage cooling of Long Wave Infrared (LWIR) sensors and optics for space applications

DESCRIPTION: Next generation space infrared sensing technologies and spacecraft cryocooling needs will require significant improvements in technology to meet emerging system needs. Multistage cryocoolers offer large potential system gains in cooling efficiency and system optimization. Multistage cooling differs greatly from typical single stage cryogenic cooler and has a host of technical difficulties associated with the development of robust cryocoolers. Current systems rely on state of the art technology that employs cooling at a single cryogenic temperature, necessitating the need for multiple coolers for the different cooling requirements such as the sensor, shields, and optical benches. If redundancy is required, the number of coolers needed doubles and imposes significant system mass and power penalties. An additional area of concern is the development of high capacity cryocoolers to satisfy cooling requirements for future systems, specifically at 35 Kelvin for Long Wave Infrared (LWIR) sensors and optics for space applications. Improvements sought in current technology include enabling efficient, compact, low mass multistage cryocooler capable of producing continuous high capacity 35 Kelvin cooling. Potential cooling requirements range from 2 Watts cooling at 35 Kelvin and 20 Watts cooling at 85 Kelvin (simultaneously) to coolers capable of producing 8 Watts cooling at 35 Kelvin.

Phase I: Phase I SBIR efforts should concentrate on the development of the fundamental concepts. This could include demonstration of a process or fundamental physical principle in a format that illustrates how this technology can be further developed and utilized in a cryocooler or as a cryocooler. This effort should include plans to further develop and exploit this technology in Phase II.

Phase II: Phase II SBIR efforts should take the innovation of Phase I and design/develop/construct a breadboard device to demonstrate the innovation. This device may not be optimized to flight levels, but should demonstrate the potential of the working prototype device to meet emerging operational specifications. Demonstration of the potential improvements in mass, input power, efficiency, reliability, and/or cryogenic system integration should be included in the effort. The contractor should keep in mind the goal of commercialization of this innovation for the Phase III effort.

Phase III: Typical MDA military space applications relate to infrared sensing, cryogen management, electronics cooling, and superconductivity. Potential Phase III opportunities to transfer this technology to emerging MDA programs include the Advanced Space Based Infrared System and block upgrades to the Space Based Infrared System Low.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The applications of this technology could potentially have large market potential. Applications of this technology include NASA, civil, and the commercial sector for space based and airborne uses such as missile tracking, surveillance, astronomy, mapping, weather monitoring, and earth resource monitoring. The need for high reliability cryocoolers for terrestrial applications includes cellular bay station cooling and magnetic resonance imaging. Other potential applications include CMOS (complimentary metal-oxide semiconductor) cooling for workstations and personal computers.

References:

1. Davis, T. M., Tomlinson, B. J., and Ledbetter, J., "Military Space Cryogenic Cooling Requirements for the 21st Century", Cryocoolers 11, R. G. Ross, Jr., Ed., Plenum Press, New York (2001), pp. 1-10.
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4. R. C. Bowman Jr., B. D. Freeman, et al., “Design and Evaluation of Hydrogen Joule-Thomson Sorption Cryocoolers”, Proceedings of the International Absorption Heat Pump Conference, New Orleans 19-21 Jan 1994, p. 265-271.
5. Nellis, G., F. Dolan, W. Swift, and H. Sixsmith, "Reverse Brayton Cooler for NICMOS," Cryocoolers 10, R. G. Ross, Jr., Ed., Plenum Press, New York (1999), pp. 431-438.

KEYWORDS: Cryocooler, cryogenic, Stirling, Brayton, pulse tube, multistage, high capacity

MDA02-031 **TITLE**: MEMS Technology for Cryogenic Cooling

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: MDA/SS

OBJECTIVE: Develop next generation cryogenic cooling technology based on Micro Electrical Mechanical System (MEMS) fabrication processes and techniques

DESCRIPTION: Next generation space cryogenic cooling technology will require revolutionary leaps in mechanical efficiency and miniaturization to meet emerging space based requirements. Micro Electrical Mechanical System (MEMS) processes and technology provides potential solutions to achieving long life, high reliability, efficient cryogenic cooling for infrared sensors, on orbit cryogen storage, supercooled electronics, and other superconductivity applications. MEMS fabrication and assembly techniques can be applied to an array of mechanical designs for hermetic closed cryogenic cooling cycles including Stirling cycle, pulse tube (Stirling variant), reverse Brayton cycle, and the Joule-Thomson cycle. Advances in fabrication of high effectiveness heat exchangers, compressors, expanders, turbines, and overall mechanical cryocooler packaging will enable vast reductions in mass and volume while increasing efficiency and reliability. Technology of interest would provide cryogenic cooling between 10 and 100 Kelvin for specific military applications. Innovative proposals should address development of MEMS technology for critical components or complete cryocooler systems that have potential applications in space.

Phase I: Phase I SBIR efforts should concentrate on the development of the fundamental concepts. This could include demonstration of a process or fundamental physical principle in a format that illustrates how this technology can be further developed and utilized in a cryocooler or as a cryocooler. This effort should include plans to further develop and exploit this technology in Phase II.

Phase II: Phase II SBIR efforts should take the innovation of Phase I and design/develop/construct a breadboard device to demonstrate the innovation. This device may not be optimized to flight levels, but should demonstrate the potential of the working prototype device to meet emerging operational specifications. Demonstration of the potential improvements in mass, input power, efficiency, reliability, and/or cryogenic system integration should be included in the effort. The contractor should keep in mind the goal of commercialization of this innovation for the Phase III effort.

Phase III: Typical MDA military space applications relate to infrared sensing, cryogen management, electronics cooling, and superconductivity. Potential Phase III opportunities to transfer this technology to emerging MDA programs include the Advanced Space Based Infrared System and block upgrades to the Space Based Infrared System Low.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The applications of this technology could potentially be far reaching with large market potential. Applications of this technology include NASA, civil, and the commercial sector for space based and airborne uses such as missile tracking, surveillance, astronomy, mapping, weather monitoring, and earth resource monitoring. The need for high reliability cryocoolers for terrestrial applications includes cellular bay station cooling and magnetic resonance imaging. Other potential applications include CMOS (complimentary metal-oxide semiconductor) cooling for workstations and personal computers.

References:

1. Davis, T. M., Tomlinson, B. J., and Ledbetter, J., “Military Space Cryogenic Cooling Requirements for the 21st Century”, Cryocoolers 11, R. G. Ross, Jr., Ed., Plenum Press, New York (2001), pp. 1-10.
2. R. C. Bowman Jr., B. D. Freeman, et al., “Design and Evaluation of Hydrogen Joule-Thomson Sorption Cryocoolers”, Proceedings of the International Absorption Heat Pump Conference, New Orleans 19-21 Jan 1994, p. 265-271.
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KEYWORDS: Micro Electrical Mechanical System, MEMS, cryocooler, cryogenic, Stirling, Brayton, pulse tube, heat exchanger, compressor, expander, turbine

MDA02-032 **TITLE**: Electronically adaptive ballistic missile target signature

TECHNOLOGY AREAS: Battlespace, Space Platforms

ACQUISITION PROGRAM: MDA/TC

OBJECTIVE: Demonstrate electronic methods to artificially present passive radio frequency (RF) signature characteristics of objects in such a way that allows alternative signature characteristics to be selected in advance for an object that will be sensed in a defined frequency band.

DESCRIPTION: The measurable characteristics (i.e., signature) of an observed object are key variables in determining what sensor capabilities are needed for detecting, acquiring, classifying and tracking it and, if necessary, discriminating it from other objects. Testing sensor performance against a full range of actual objects of interest for that given sensor design is ideal but not always feasible. For testing radar performance against ballistic missile objects in flight, for example, limited access to foreign assets leads to use of surrogate target systems. Producing tailored, threat-like surrogates individually is expensive and requires long development times. The ability to replicate a range of object signatures with common surrogates would streamline testing. Targets or payloads with such a feature would more fully exploit the finite resources and lead-times required for live testing and would enable "off-the-shelf" target items to be used for meeting a wide range of test requirements.

The objective of this topic is to develop and apply technology to be able to electronically adapt the passive RF signature characteristics of a space object to a viewing sensor. The feasibility of the technology should be demonstrated in relation to objects on ballistic trajectories in space and in the upper atmosphere. Demonstrated technology must be applicable to lightweight and compact components suitable for integration within a ballistic missile target surrogate re-entry vehicle or deployment as part of a ballistic missile target payload.

PHASE I: Demonstrate the technical feasibility of innovative designs or tuning techniques which, individually or in combination, could be applied to objects with the physical dimensions and payload constraints of a ballistic missile target to produce varied, artificial RF signature characteristics in each of the following frequency bandwidths: C-band, S-band, and X-band.
PHASE II: Develop and test a prototype target object employing the demonstrated technology, including features to allow advance selection of multiple, alternative signatures to a viewing sensor. Conduct the test in each of the following frequency bandwidths: C-band, S-band, and X-band.
PHASE III: Apply demonstrated technologies, designs, prototype hardware and system integration techniques in the development and production of ballistic missile target components.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Technologies demonstrated and design approaches successfully applied to this project are applicable for design and production of other space vehicles, aviation platforms, and terrestrial objects. This project seeks innovation for purposes of testing, which responds to requirements in commercial aviation and other product testing, for example, as well as for military R&D. Moreover, a successful technology approach will be broadly applicable in operational systems that require signature masking or deception. Meeting the environmental and physical constraints of a ballistic missile target will result in technology that is sufficiently miniaturized and reliable to be adaptable for a range of platforms and mission applications.

REFERENCES: None.

KEYWORDS: Adaptive, RF signatures, Optical signatures, Ballistic missile targets

MDA02-033 **TITLE**: Secure, high bandwidth telemetry

TECHNOLOGY AREAS: Information Systems, Battlespace, Space Platforms

ACQUISITION PROGRAM: MDA/TC

OBJECTIVE: Demonstrate small, secure wireless data transmission devices that will broadcast encoded formats in the S- and L-bands to line-of-site distances of 300-500 km.

DESCRIPTION: Telemetry systems for ballistic missile vehicles are limited in broadcasting range. Telemetry requirements for broadcast distances and data rates vary with test ranges and scenarios, but they are increasing overall as flight test geometries extend over higher altitudes and broad ocean areas, with related range safety capabilities becoming increasingly demanding. To meet these demands for continuous, real-time data streams to more distant relays or receiving stations, ballistic missile targets require telemetry broadcast components with innovative features to overcome existing constraints on telemetry system performance. The technology must be applicable within the physical limitations and environmental stress conditions of target launch vehicles and payloads.

The objective of this topic is to develop and apply wireless technology, to include antennas and signal processing, that can achieve a long-range, high bandwidth capacity in secure encoded formats for telemetry devices that will operate over under the physical and signature constraints of a surrogate ballistic missile and the environmental conditions of a space vehicle being placed into a sub-orbital trajectory.

PHASE I: Demonstrate the technical feasibility of innovative designs in achieving the desired range and bandwidth capacities with small size components.
PHASE II: Develop and test prototype processing and transmission equipment with form and fit characteristics suitable for a target launch vehicle and target payload.
PHASE III: Apply innovative components and related processes in the development and production of ballistic missile target systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial potential from the ballistic missile target industry exists in response to the increased pace of future BMD flight testing and associated demands for targets. Moreover, innovations demonstrated will be applicable in supporting industry solutions for standardizing telemetry systems to the extent possible for use of targets and space launch systems at multiple DoD missile and space launch ranges. Commercial potential in non-defense industries is focused in wireless telecommunications.

REFERENCES: None.

KEYWORDS: Telemetry, wireless, data transmission, space vehicles

MDA02-034 **TITLE**: Corrosion Protection of High-Value Test & Evaluation Assets

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: MDA/TE

OBJECTIVE: The objective of this research and development effort is to provide significant enhancement to the corrosion protection of high-value missile defense test & evaluation facilities, equipment, and components.

DESCRIPTION: Missile defense test programs require the placement and utilization of test assets at remote facilities, e.g. U.S. Kwajalein Atoll (Marshall Islands), Pacific Missile Test Range (Hawaii), and Alaska. Corrosion of both ferrous and aluminum alloys represents a significant problem in maintenance of these test assets. Research and development in improved methods for extended-life corrosion protection in highly aggressive environments is needed. Substantial latitude is left to interested firms in proposing advanced material concepts and processing techniques that could be applied to meet these needs. Such enabling materials and process technologies would be readily adaptable to commercial applications, providing for dual-use applicability.

PHASE I: Conduct experimental efforts to demonstrate proof-of-principle of the proposed technology to include materials fabrication, characterization and testing.

PHASE II: Demonstrate feasibility of engineering scale-up of proposed process; identify and address technological hurdles, and characterize the performance of novel materials. Demonstrate applicability to both selected military and commercial applications.

PHASE III: This SBIR would have direct applicability to on-going and future test programs for missile defense systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Equally important to military utility is the transferability of such advanced materials and process technology to corrosion protection in aerospace, automotive, and industrial uses. As enabling technology, it is anticipated that commercial and industrial transferability and applicability will be high.

KEYWORDS: Corrosion protection, test & evaluation, radar platforms, IR/optical sensors, ferrous alloys, aluminum alloys.

MDA02-035 **TITLE**: Multi-Spectral Sensors and Cameras for Test Applications

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: MDA/TE

OBJECTIVE: The objective of this research and development effort is to provide a new state-of-the-art multi-spectral sensor for acquiring data in missile defense tests. The sensor should be small enough for use on a unmanned aerial vehicle (UAV).

DESCRIPTION: Missile defense test programs require the acquisition of a broad spectrum of data for each mission to validate the test. The development of a small, capable multi-spectral sensor for use on a UAV will greatly enhance MDA's data collection options and capabilities. The camera should be capable of sampling in at least three bands, UV, visible and near IR, with wavelengths from 280-900 nm. The camera should be small, low power and able to acquire data at a 30 Hz frame rate in each of the three bands with at least a 1920X1080 pixel resolution. Small size and low power are required for use on a UAV as well as other applications. The use of a UAV will allow the sensor to get closer to the trajectory of the missile with minimal safety concerns.

PHASE I: Conduct experimental efforts to demonstrate proof-of-principle of the proposed technology in one of the spectral bands to include characterization and testing.

PHASE II: Demonstrate feasibility of a three-band sensor; identify and address technological hurdles, and characterize the performance of the camera. Demonstrate applicability to both selected military and commercial applications.

PHASE III: This SBIR would have direct applicability to on-going and future test programs for missile defense systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Equally important to military utility is the transferability of such advanced multi-spectral capabilities to commercial applications. The camera will have a broad range of applicability to commercial applications where remote operation and sensing is required, such as hazardous operations, space applications and crop monitoring. As a sensor technology, it is anticipated that commercial and industrial transferability and applicability will be high.

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KEYWORDS: Multi-spectral, UV, Visible, Near IR, Sensor, High resolution, High definition.

MDA02-036 **TITLE**: Compact High Bandwidth Wireless Data Links

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: MDA/TE

OBJECTIVE: The objective of this research and development effort is to provide a new state-of-the-art wireless data-link for transferring data from sensors, both optical and radar, observing missile defense flight tests. The development should start with an inter-range system and develop into a system for use on an unmanned aerial vehicle (UAV) carrying sensors in support of MDA testing.

DESCRIPTION: Missile defense test programs require the acquisition of a large volume and broad spectrum of data for each mission to validate the test. The development of a small, very high bandwidth wireless data link for use on a UAV will greatly enhance MDA's data throughput capabilities. The point-to-point wireless data link should be capable of supporting multi-gigabit/second data rates over a distance of at least 10 miles. At least 1 Gb/sec throughput is required and 10 Gb/sec is desired. The data link should capable of operating in light rain and fog conditions. Link status monitoring capability should also be included in the system. The data link should also have the capability of being reduced in size to be used at shorter ranges on a UAV for data downlink. The use of a UAV will allow the sensor to get closer to the trajectory of the missile with minimal safety concerns.

PHASE I: Conduct experimental efforts to demonstrate proof-of-principle of the proposed technology to include characterization and testing.

PHASE II: Demonstrate feasibility of a high bandwidth, 1-10 Gb/s, wireless data link; identify and address technological hurdles, and characterize the performance of the system. Demonstrate applicability to both selected military and commercial applications.

PHASE III: This SBIR would have direct applicability to on-going and future test programs for missile defense systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Equally important to military utility is the transferability of such advanced high bandwidth data link capabilities to commercial applications. The data link will have a broad range of applicability to commercial applications where high bandwidth is a requirement; remote sensing, broadband internet links and data transfer. As a data transfer technology, it is anticipated that commercial and industrial transferability and applicability will be high.

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3. Wisely, D.R., A 1 Gbit/s optical wireless tracked architecture for ATM delivery, IEE Colloquium on Optical Free Space Communication Links, P. 14/1 -14/7, 1996.

KEYWORDS: Wireless Data Link, Gigabit, Point-To-Point, Lightweight, and Tracking.

MDA02-037 **TITLE**: Techniques for Missile Defense

TECHNOLOGY AREAS: Sensors, Weapons

ACQUISITION PROGRAM: MDA/AC

Objective: Develop innovative concepts for performing the missile defense mission. MDA increasingly depends on advanced technology developments, of all kinds, to invigorate its ability to find and disable missiles in flight and to defend against an increasingly sophisticated threat, to include cruise missiles. Therefore, the continued availability of emerging technology has become a vital part of the MDA mission. MDA has interest in specific technology programs that pursue high-risk technologies that could spur a revolutionary leap or enhancements. Specific goals include, but are not limited to, quickening the pace of technology and innovation developments and decreasing the time required to transform scientific breakthroughs into actual applications. Research or Research and Development efforts selected under this topic shall demonstrate and involve a degree of technical risk where the technical feasibility of the proposed work has not been fully established.

Description: The ballistic missile threat continues to evolve. The Missile Defense Agency is developing a flexible architecture to counter the ballistic missile threat. This effort would develop a technique to counter ballistic missiles that can be further developed and integrated into the missile defense architecture. Areas of interest include but are not limited to:
Radar Systems, Cross sections and signatures, Measurements (waveforms, data extraction), Hardware (transmit/receive modules), Signal processing, Data visualization, Data compression, and Image interpretation.
Lasers and Electro-optical Systems, High energy lasers, Passive IR and optical systems, Ladar systems, Optical signal processing, and Hardware (FPA).

Mathematics and Computer Science, Algorithms, Artificial intelligence, Software
Probability/statistics, and Pattern recognition.
Electrical Engineering, Digital electronics and signal processing, Machine implementation of algorithms, Analog circuits/rf communications, Computer vision, and Distributed computing.
Physics and Chemistry, Electrodynamics, Nuclear physics and weapons effects, Infrared and optical signatures, Energy conversion, and Rocket plume analysis.
Mechanical and Aerospace Engineering, Space systems.
Missile systems aerodynamics, propulsion, Guidance and control, and reentry physics.
Materials science.
Battle Management/Command and Control, Engagement planning, Tactics, intelligence exploitation, and countermeasures.
Decision theory and modeling.
Target tracking, classification, identification, and discrimination.
Sensor fusion.

PHASE I: Identify and describe an innovative technique for disabling inbound ballistic missiles.
PHASE II: Continue to develop the technique. Support the analysis of the technique's effectiveness.
PHASE III: Further refinement of the technique and transition to the BMD system developers.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Depending on the nature of the prescribed technique, there may be commercial applicability.

References: None

KEYWORDS: missile defense; innovation; threat; advanced; concept; analysis, opportunities

MDA02-038 **TITLE**: Advanced Divert and Attitude Control Systems (DACS)

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: MDA/TH

OBJECTIVE: The objective of this research and development effort is to develop innovative high performance component technologies that will enhance the capability of divert and attitude control systems(DACS).

DESCRIPTION: Improved DACS technology is needed to address insensitive munitions and safety requirements, while maximizing the kill vehicle (KV) divert/attitude control capability, and reducing the KV weight within restricted geometries. A host of interrelated technologies include low cost/high performance nozzle materials; non-toxic propellants, insensitive propellants, alternative pressurization schemes, etc. are of interest. The candidate DACS technologies should be lightweight (low density), have high fracture toughness, retain their strength at elevated temperatures, and resist to the propellant environment without supplemental oxidation protection. The innovative fabrication processes employed in the development of the advanced DACS should be able to fabricate complex shapes with rapid fabrication techniques at reduced manufacturing cost. Numerous candidates for fit, form and functional component replacements may be available in time to support a near term insertion opportunities.

PHASE I: Conduct experimental and analytical efforts to demonstrate proof-of-principle of the proposed technology to enhance DACS performance.

PHASE II: Demonstrate feasibility and engineering scale-up of proposed technology; identify and address technological hurdles. Demonstrate applicability to both selected military and commercial applications.

PHASE III: The developed technology has direct insertion potential into Theater missile defense systems such as THAAD, and GMD concepts.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The proposed technology would have applicability to commercial space platforms, thermal protection materials and control surfaces, automobile components such as turbochargers, high temperature environment systems such as recuperators in melt furnaces, jet APU ring motors etc.

REFERENCES:

1. S.J. Schneider, "High Temperature Thruster Technology for Spacecraft Propulsion", IAF Paper 91-254, presented at 42nd IAF Congress, Montreal, Canada, October, 1991.

2. P.Hill, C.Peterson, “Mechanics and Thermodynamics of Propulsion” Second Edition, Addison Wesley, 1992.

KEYWORDS: DACS, interceptor kill vehicle, divert and attitude control, nozzle materials, propellant.

MDA02-039 **TITLE**: Advanced Seeker Technologies

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: MDA/TH

OBJECTIVE: Develop advanced sensors and supporting technologies to support multiband (IR and Visible) imagery for target detection and discrimination. This encompasses advanced window designs, multicolor infrared (IR) focal plane arrays, and imaging LADARs.

DESCRIPTION: Advanced seekers are required to provide for enhanced target detection, on-board discrimination and improved end-game guidance for hit-to-kill interceptors used in missile defense systems. These on-board sensors must be compatible with the existing hardware. The specific technology areas to be investigated are advanced window designs, multicolor focal plane arrays (FPA), and Range-Resolved Doppler Imaging LADAR capabilities.

The optical windows used on a kill vehicle (KV) must be ruggedized to withstand the operational environment of the kill vehicle. The research tasks are to develop an optical window(s) that will provide extended MWIR, LWIR, LADAR, and multicolor sensor operation in a highly stressing environment. There is a need for a near-term replacement for the existing sapphire window used for extended MWIR sensors with a longer-term need for the full optical range.

The multicolor FPA sensor technology is to develop a single FPA design that will provide two, or more, colors at full resolution to replace the multiple FPAs currently required for multicolor optical seekers. The FPA should have MWIR/LWIR capability and provide good pixel-to-pixel uniformity and low readout noise while delivering a high quantum efficiency. There is also a need to develop a multicolor VLWIR FPA with similar performance.

The combination of a Range-Resolved Doppler Imaging LADAR with a multicolor IR seeker provides a three-dimensional imaging capability that will reduce or eliminate dependency on a priori data for target aimpoint selection. Technologies that enhance the beam quality, pulse repetition rate, efficiency and power of the LADAR are critical to the optimal performance of this technology.

PHASE I: Design, fabricate and provide proof-of-principle demonstrations of advanced seeker sensor technologies.

PHASE II: Develop prototype seeker systems and demonstrate these in a simulated flight environment. These tests should include environmental testing to ensure reliable operation in a stressing, realistic operational environment.

PHASE III: Integrate seeker technology into interceptor designs for incorporation in block upgrades.

PRIVATE SECTOR COMMERCIAL APPLICATIONS: The sensor technologies being developed in this effort will have dual application in law enforcement and for material processing to detect material defects.

KEYWORDS: Seeker, Multicolor Focal Plane Array, LADAR, MWIR, LWIR, VLWIR

MDA02-040 **TITLE**: Integrated Data Compression and Security Algorithms

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: MDA/TH

OBJECTIVE: The objective of this research and development effort is to develop improved data compression and security algorithms and techniques. Integration of these advanced algorithms would allow increased data flow among the weapon system elements in a secured manner leading to more efficient processing of mission critical information.

DESCRIPTION: The state of the art algorithms used for data compression and security are not adequate to meet existing Theater Missile Defense (TMD) needs. While NSA approved encryption algorithms exist, they need to be integrated with advanced data compression techniques to fully address TMD needs. Application of these technology advancements to the TMD domain would enable an increased interceptor telemetry capability, including real time seeker FPA data, and ultimately enhance battlefield

learning opportunities. Secure, high-speed information flow among the weapon system elements would improve system responsiveness, while precluding the compromise of critical technologies following accidental loss or capture. Algorithms could be developed, integrated, and validated in time to support a near term insertion opportunity.
PHASE I: Conduct experimental efforts to demonstrate proof-of-principle of the proposed algorithm technology to compress relevant TMD data in a secure environment. Demonstrate the initial feasibility of integrating the algorithms into an existing system.
PHASE II: Demonstrate feasibility and engineering scale-up of proposed technology; identify and address technological hurdles. Demonstrate applicability to both selected military and commercial applications.
PHASE III: Integrate algorithms into TMD systems and demonstrate the total capability of the updated system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The data compression and security algorithms have commercial applicability in applications where content-rich data is required to be transferred in a secure manner to ensure data integrity. Specific private sector areas with significant commercial potential include the electronic commerce and wireless transmissions industries.

REFERENCES:
1. J.S. Przemieniecki, Critical Technologies for National Defense, AIAA Education Series, Washington, D.C., 1991.
2. David Salomon, Data Compression, The Complete Reference, Springer, New York, 2000.

KEYWORDS: data compression, security, algorithms, data, information technology, data loss, data processing, data integrity

MDA02-041 **TITLE**: Miniature Interceptor Technology

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: MDA/AT

OBJECTIVE: The objective of this research and development effort is to develop innovative interceptor technologies that enable low mass, highly efficient , agile interceptors to defend against current and projected advanced BMDO threats.

DESCRIPTION: Miniature interceptors, especially an integrated version of them launched from a single booster that could intercept multiple objects, have the potential to solve many difficult countermeasure problems, such as antisimulation, submunitions, encapsulated reentry vehicles(RVs) etc. In order to accomplish this, miniature interceptors weighing 250 grams to 1 kilogram and costing less than $15K are required. A host of innovative miniature technologies are needed to enable this new paradigm. These technologies include highly efficient structures(<0.3 gr/cc), miniaturized power sources with energy densities (>30 W sec/gram), miniature propulsion systems with deltaV>1000m/sec/Kg(deltaV/vehicle mass) and impulse variation of +/- 1% 3sigma, light weight optics, high data rate MEMS inertial measurement units, innovative fabrication techniques etc. These technologies can be applied not only to the miniature interceptors referenced above but they can also be integrated into current missile systems and their upgrades.

PHASE I: Identify and define the proposed technology. Conduct analytical and experimental efforts to demonstrate proof-of-principle and establish basic performance criteria and areas for further refinement in Phase II.

PHASE II: Demonstrate feasibility and engineering scale-up of proposed technology. Fabricate a prototype that demonstrates capabilities defined during Phase I and demonstrate the technology in a laboratory environment and finally with field tests.

PHASE III: The developed technology has direct insertion potential into Theater missile defense systems such as THAAD, and GMD concepts.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technologies developed under this SBIR topic would have applicability to automobile industry such as air bag initiators, brake sensors etc., to the airline industry such as IMU technology, lightweight materials etc., space vehicles.

REFERENCES:

1. Lianos D., Strickland B., “ A midcourse Multiple Kill Vehicle Defense Against Submunitions”, 6th Annual AIAA/BMDO Technology Readiness Conference, San Diego, CA, August 1997.

2. Legters G., Lianos, D., Brosch, R., “Highly Integrated Spinning Projectile (HISP)”, AIAA 92-1214 1002 Aerospace Design Conference, February 3-6, 1992.

KEYWORDS: interceptor, guidance, sensor, MEMS, power sources

MDA02-042 **TITLE**: Modular Micro Processor Assembly Utilizing High Speed Interconnect

TECHNOLOGY AREAS: Information Systems, Electronics, Weapons

ACQUISITION PROGRAM: MDA/AT

OBJECTIVE: Microprocessor technology continues to evolve and remains a crucial part of today's complex missiles such as THAAD, NMD, and PAC-3. An avionics-advanced seeker electronics system with associated advanced processing capabilities is required to employ a new generation of high speed interconnect.

DESCRIPTION: One approach to aid in advanced missile system development is to modularize the processor function to aid in expandability and upgrade-ability. An innovative design of an embedded missile multiprocessor based system that supports expandability is needed to support these missile programs. In the past PMC (PCI mezzanine card) processor modules have been successfully used to demonstrate modularization of the missile avionics system design. These assemblies allow the processing node to be independently upgraded as advances are made in the COTS (Commercial off the Shelf) microprocessor arena. This approach allows independent development and insertion of the specific missile IO signaling interfaces such as DAC thruster control and advanced seeker interfaces. An innovative design of a "PMC like" module that replaces the standard PCI bus signal interface with a high speed packetized switch fabric such as RapidIO is the next logical step in a modularized approach to missile system development.

With a high-speed switch fabric interface connected directly to the processing node, a common, deterministic, low latency connection can be provided for each processing node. These modules would retain a "PMC like" mechanical form factor to support independent development of the missile system chassis and signal IO assemblies. They would replace the limited capability of a shared bus PCI signaling interface with one that supports the high-speed switched fabric. With the switched fabric interface to each processing node, expandability would be achieved by simply adding more processing modules to the fabric. Since the high-speed interconnect is a point-to-point packetized architecture, each node would maintain full IO interface bandwidth as more nodes are added to the system.

PHASE I: Demonstrate the feasibility that an innovative research and development approach can address the critical need for improvement in modularized processing with high speed interconnect capability.

PHASE II: Develop proof-of-concept components and/or prototype hardware to demonstrate the approach defined in Phase I.

PHASE III: Integrate/transfer the technology into ballistic missile applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The proposed technology would have extremely limited commercial application due to its special purpose nature for military applications.

REFERENCES:

1. InfinibandTM Architecture Specification, Volumes 1 and 2, Release 1.0" InfinibandSM Trade Association October 24,2000.

2. RapidIO Trade Association, RapidIO Interconnect Specification. Rev1.1 3/2001.

KEYWORDS: Avionics, seeker, High speed interconnect, fabric switch

MDA02-043 **TITLE**: Passive, Active Stokes Polarization Imaging System

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: MDA/AT

OBJECTIVE: Develop a passive or active polarimetric imaging sensor operating in the UV/Visible, Mid Wave Infrared(MWIR), and/or Long Wave Infrared(LWIR) spectral bands

DESCRIPTION: Stressing issues associated with BMD archirectures include target discrimination, aim point selection for interceptors, target orientation determination, separation of a booster or bus from the associated plume, kill assessment, hard body/wake separation. The boost phase intercept requires location an aim point on the rocket hard body against its intense plume and backgrounds. In midcourse, an interceptor should be able to discriminate a target from deployed decoys. In reentry phase, a target is heated by the atmosphere and a wake may extend along the path of the target trajectory. Stress exerted on the target can cause break-up of the target and produce a debris cloud which moves along with the target. Reentry intercept requires location of an aim point against the atmospheric background and wakes, and discrimination of a warhead from debris. A polarimetric imaging sensor (Interceptor and/or other platform based) can provide solutions to these problems.

PHASE I: Design a spectral polarimetric sensor that will be used in high velocity interceptors or air or space based platforms, that operates in near real time and operates in either UV/visible or IR spectra bands. Special attention should be placed in minimization of moving parts required, frame rate, and light captured.

PHASE II: Fabricate a prototype that demonstrates capabilities defined during Phase I and demonstrate sensor in a laboratory environment and finally with field tests against static and moving objects of interest.

PHASE III : Integrate and produce polarization imaging systems for insertion into air and space sensor platforms and interceptor systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial market for spectral-polarization imaging devices is significant. Commercial application areas include vegetation mapping in agriculture, environmental monitoring such as pollution, geological surveys, medical diagnostics, process and quality control monitoring, robotics, forestry, etc.

REFERENCES:

1. R. A. Chipman, E.A. Sornsin, and J.L. Pezzaniti, “Mueller matrix imaging polarimeter: An overview” SPIE Volume 2873, June 1996
2. Shin-Yau Lu and R.A. Chipman, “Interpretation of Mueller matrices based on polar decomposition”,JOSA Volume 13, No. 5, May 1996
3. D. Lianos, S. Hammonds, “UV/Visble Polarimetric Signatures for Discrimination”, SPIE Volume 1467, July 1994

KEYWORDS: Polarization, Imaging, Spectral, Stokes vector, Interferometer

MDA02-044 **TITLE**: Improved VLA (very low absorption) Coatings

TECHNOLOGY AREAS: Materials/Processes, Sensors

ACQUISITION PROGRAM: MDA/AL

OBJECTIVE: Develop optical coatings that have high reflectivity at specific laser wavelengths.

DESCRIPTION: Develop new high reliability, cost effective, reflective or transmissive coatings and application techniques for reflection or transmission of high intensity laser fluences. Few optical coating technologies currently exist that can withstand high intensity laser fluences. New coatings need to be developed that are alternatively highly reflective/very low absorbing or highly transmissive/anti-reflective. These coatings need to be affordable, easily applied to various optical substrates, and easy to maintain in field conditions. Additionally, the mechanical stresses induced in the substrate by its coating must be as low and as uniform as possible. Undue stresses will cause premature substrate failure or disruption of the optical wavefront impinging on the optical surface(s).

PHASE I: Develop/define proposed coating concepts, specific requirements (including application processes) and predicted performance. Demonstrate basic system concepts in a laboratory environment.

PHASE II: Provide laboratory demonstrations of prototype coating and application technique/process to mutually agreed performance parameters. Broad spectrum, high capability, coating demonstrations must be capable to support ground demonstrations and airborne demonstrations at government facilities. The prime consideration must be deliverable coatings and a clear demonstration of the high-energy applications that will demonstrate a 20-year lifetime.

PHASE III: Directed energy systems such as Space Based Laser and Airborne Laser are most interested in the development of new coatings and application techniques..

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial application, especially in the drilling and cutting environments, are beginning to broaden the scope of applying this technology.

REFERENCES: (1) Pond, B.J. et al., " High power 1.315 um laser test of multilayer mirrors," Laser-induced damage in Optical Materials: 1993, SPIE, v 2114, 1994, pp. 335-344. (2) Watkins, S.E., et al., " Mapping of absorption in optical coatings, " Laser-induced Damage in Optical Materials: 1991 SPIE, v. 1624, 1992, pp.246-255.

KEYWORDS: Highly reflective/very low absorbing; Highly transmissive/anti-reflective; Mechanical stresses ; Optical wavefront impinging; High laser fluences; Optical substrates.

MDA02-045 **TITLE**: Improve/develop metrology for VLA (very low absorption) Coatings

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: MDA/AL

OBJECTIVE: Improve current or develop new methods for measuring the quality of optical coatings.

DESCRIPTION: Develop new technology or method for testing the integrity of optical coatings used in high-energy applications. Currently, limited technologies exist to test optical coatings. Most can only be used after the coating has been applied and the finished optic removed from the coating chamber. Ideally measurements would allow real time analysis while a multi-layer coating is being applied. Measurements need to include bulk absorption & transmission, scatter, and wavefront distortion at various wavelengths. Additionally, coating mechanical strength, adhesion, and laser damage thresholds need to be analyzed. Brute force methods like seeing is 'scotch tape' will lift a coating offer limited information.

PHASE I: Define the proposed Metrology concept, specific measurement requirements, and predict the performance of the proposed technology. Demonstrate basic Metrology concepts in a laboratory environment.

PHASE II: Provide a prototype system and laboratory demonstration to mutually agreed performance parameters. Demonstration Metrology techniques which must be capable to support high energy ground demonstration in a government facility and be qualifiable for airborne experiments. The prime consideration must be deliverable of metrology system to measure optical coating used in high power applications and a clear demonstration of real time analysis.

PHASE III: All system using optics will benefit from this technology. The Directed energy systems within DoD would immediately benefit as would those commercial systems, such as astrology systems using adaptive optics.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial systems, that use adaptive optics such as astrology, would benefit by being able to accurately measure the quality of the optics during production..

REFERENCES: (1) Bailey, R.T. et al., "Quantitative measurement of energy deposited in optical coatings," Max Born Centenary Conference proceedings, Sept 7-10, 1982, Edinburgh, Scotland, SPIE, v 369, 1983, pp. 88-89. (2) Reicher, D.W., et al., "Photoacoustic characterization of surface absorption," Laser-induced damage in Optical Materials: 1990, SPIE, v 1441, 1991, pp. 106-112.

KEYWORDS: Optical coatings; Coating chamber; Bulk absorption & transmission; Scatter & wavefront distortion; Multi-layer coating; Laser damage thresholds

MDA02-046 **TITLE**: Air-transportable, Rapid Production Mixed-base Hydrogen Peroxide System

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: MDA/AL

OBJECTIVE: Develop and demonstrate a compact, air-transportable, rapidly assembled, mixed-base hydrogen peroxide production system (pilot-scale).

DESCRIPTION: The system must produce a minimum of 3,000 kg in three hours (1,000 kg/hr) of mixed base hydrogen peroxide (MHP) solution consisting of de-ionized water, potassium hydroxide (KOH), sodium hydroxide (NaOH), lithium hydroxide (LiOH), and hydrogen peroxide. The system must produce adequate de-ionized water from potable water supplied at the operating site. The system must utilize premixed caustic solutions, individual caustics as well as mixed base, and 70-wt% hydrogen peroxide as reagents. The system must provide for all possible orders of addition for each of the caustic solutions in the blend procedure. The system must receive liquid caustic from a caustic supply tank, not a part of this system. The system must have adequate controls and automation to allow the selection of specific proportions of each caustic, water and hydrogen peroxide as well as provide for the selection of a pre-determined blend procedure. The system must have sufficient storage for 6,000 kg of MHP solution. The system must maintain a blend temperature of 0°C ±5°C and be capable of chilling the product to -15°C. The system must have adequate automation and controls to produce specified formulations to within ±0.5%.

Phase I: (1) Develop a process flow diagram with material and energy balance for a deployable (air transportable) MHP production facility capable of producing 1,000 kg/hour. (2) Develop piping and instrumentation diagrams (P&ID's) for a deployable, air-transportable MHP production facility. (3) Prepare a major equipment list and specifications to include materials of construction and power requirements. (4) Develop a preliminary layout design with a general arrangement of equipment. And (5) prepare an electrical single line diagram for the system.
Phase II: (1) Complete detailed engineering of MHP prototype. (2) Procure and fabricate MHP prototype system. (3) Demonstrate prototype system setup, checkout, operation, and breakdown.
Phase III: If Phase II is successful, the system will be scaled up to full-scale (approximately 3x to 5x) and 3 to 10 systems will be produced for weapon system testing, operational training, and weapon system deployment/employment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The polymer production industry would have application for the blending system developed for this application because of the rapid cooling requirement for a high-viscosity, low-heat-transfer fluid process. The application of this technology would significantly improve polymer production efficiency and selectivity.
References: (1) High-strength, mixed-base hydrogen peroxide formulations (contact Hurley). (2) Rapid MHP blending procedures (contact Hurley)

References: None

KEYWORDS: hydrogen peroxide; basic hydrogen peroxide; BHP; mixed-base hydrogen peroxide; chemical oxygen iodine laser; COIL.

MDA02-047 **TITLE**: Gallium Nitride (GaN) Device Technology Enhancements Leading to Advanced T/R Modules for Radar Performance Enhancement

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: MDA/GM

OBJECTIVE: Identify, develop, and demonstrate GaN device technologies that advance the development of GaN-based high power amplifiers (HPAs)and T/R modules for X-Band BMD class radar systems, with increased power, bandwidth, and power added efficiency beyond that achievable in state of the art GaAs modules.

DESCRIPTION: Current and future X-Band BMD class radars (XBR) would benefit from improved resolution, enhanced discrimination, and increased power. Significant XBR performance enhancement can be achieved by development of GaN based T/R modules that incorporate power amplifiers composed of multiple GaN based transistors capable of 30 watts per module or about 3 times that of current state of the art GaAs modules operating through 10GHZ. Individual transistors should operate at power added efficiencies of 40-50% and power amplifiers at 25%. Devices should show no significant degradation in power, efficiency, or bandwidth over long periods of operation at peak power levels. This requires novel power amplifier and device designs, materials processing and production methods, and device cooling. It should be noted that current GaN High Electron Mobility Transistors (HEMTs) exhibit performance change over time at temperature and that performance-enhancing techniques such as gate recess are not established for GaN-based devices. GaN HEMTs should show no significant degradation in power, efficiency, or bandwidth over long periods of operation at peak power levels when the channel temperature does not exceed 150C.

PHASE I: Analyze, design, and conduct proof-of-principle demonstrations of advanced GaN based devices (HEMTs, Power Amplifiers, T/R modules) or technologies leading to the production of these devices.
PHASE II: Develop and demonstrate prototype devices (power transistors, amplifiers, T/R modules) that demonstrate stable device performance and meet or exceed the power, efficiency, bandwidth, and degradation goals. Develop and demonstrate new processes (or hardware) that lead to production improved devices.
PHASE III: Prepare detailed plans to implement demonstrated capabilities on critical military and commercial applications. Produce production quality HEMTs, power amplifiers, T/R modules, or devices that lead to the production of said components.

PRIVATE SECTOR COMMERCIAL APPLICATIONS: Advanced GaN based HEMTs and power amplifiers have application throughout commercial industries. Commercial radars, communications equipment, cell phones, and satellites, would benefit from this development.

REFERENCES:
1. http://nsr.mij.mrs.org/
2. http://nina.ecse.rpi.edu/shur/Tutorial/GaNtutorial2/index.htm

KEYWORDS: GaN Power Amplifiers; GaN transistors; Radar; Transmit/Receive Module; X-band; GaN based materials processing; gate recess

MDA02-048 **TITLE**: Advanced Multi-Mode Seeker Technologies

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: MDA/GM

OBJECTIVE: Develop advanced multi-mode sensor technologies to support target detection and discrimination. This encompasses multicolor infrared (IR) focal plane arrays (FPA) and imaging LADARs.

DESCRIPTION: Advanced multi-mode seekers are would provide enhanced target detection, on-board discrimination and improved end-game guidance for hit-to-kill interceptors. The technology areas to be investigated are multicolor FPAs and Range-Resolved Doppler Imaging LADAR. An FPA design should provide two or more colors at full resolution to replace the current multiple FPAs configuration employed in optical seekers. The FPA should have MWIR/LWIR, LWIR/LWIR, LWIR/VLWIR or VLWIR/VLWIR capability and provide good pixel-to-pixel uniformity and low readout noise while delivering a high quantum efficiency. The combination of a Range-Resolved Doppler Imaging LADAR with a multicolor IR seeker provides a three-dimensional imaging capability that will reduce or eliminate dependency on a priori data for target aimpoint selection. Technologies that enhance the beam quality, pulse repetition rate, efficiency and power of the LADAR are critical to the optimal performance of this technology.

PHASE I: Design, fabricate and provide proof-of-principle demonstrations of advanced seeker sensor technologies.
PHASE II: Develop prototype seeker systems and demonstrate these in a simulated flight environment. These tests should include environmental testing to ensure reliable operation in a stressing, realistic operational environment.
PHASE III: Integrate seeker technology into interceptor designs for incorporation in block upgrades.

PRIVATE SECTOR COMMERCIAL APPLICATIONS: The sensor technologies being developed in this effort will have dual application in law enforcement and for material processing to detect material defects.

REFERENCES:
1. HgCdTe photodiodes for IR detection: a review; Reine, Marion B.; AA(BAE Systems); Proc. SPIE Vol. 4288, p. 266-277.
2. Dual-band infrared focal plane arrays; Rogalski, Antoni; AA(Military Univ. of Technology); Proc. SPIE Vol. 4340, p. 1-14, 16th International Conference on Photoelectronics and Night Vision Devices, Anatoly M. Filachev; Ed.; 11/2000
3. Simultaneous MW/LW dual-band MOVPE HgCdTe 64x64 FPAs; Reine, Marion B.; Hairston, Allan W.; O'Dette, P.; Tobin, Stephen P.; Smith, F. T.; Musicant, B. L.; Mitra, Pradip; Case, F. C.; AA(Lockheed Martin IR Imaging Systems) AG(Lockheed Martin Vought Systems); Proc. SPIE Vol. 3379, p. 200-212, Infrared Detectors and Focal Plane Arrays V, Eustace L. Dereniak; Robert E. Sampson; Eds.; 7/1998.
4. Jelalian, A.V., Laser Radar Systems, Artech House, Norwood House, MA, 1992.

KEYWORDS: Seeker; Multicolor Focal Plane Array; LADAR; MWIR; LWIR; VLWIR

MDA02-049 **TITLE**: Multi-color VLWIR Focal Plane Array for Space Applications

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: MDA/GM

OBJECTIVE: Develop simultaneous/same-pixel VLWIR multiple-color-detecting focal plane arrays for space-based applications.

DESCRIPTION: This SBIR seeks Multi-Color VLWIR FPAs with high pixel uniformity, reduced readout noise, improved resolution and operability to permit tracking and discrimination at longer ranges for colder objects. Reduction in production costs will be achieved by developing fabrication and characterization methodology. Improved radiation hardness results in increased lifetime. Cost, volume, and weight (of the optics) will be reduced by providing multiple colors on a single full-resolution FPA. Risk reduction(in discrimination)accrues from the capability to increase the number of IR colors to three or four, economically. Performance enhancement by allowing dedicated separate sensors for acquisition, discrimination, and terminal guidance. The number of satellites is minimized by increasing range of detection. Reproducible technology increases yields, minimizes low-production-rate part cost.

PHASE I: Conduct experimental efforts to demonstrate proof-of-principle of the proposed technology includes design and analysis of the innovative concepts. Also include plans to further develop and exploit this technology in phase II.
PHASE II: Demonstrate feasibility and engineering scale-up of proposed technology; identify and address technological hurdles. Demonstrate applicability to both selected military and commercial applications. This phase should seek partnership with DOD prime contractors to pursue/conduct demonstration of the innovative technology to address system insertion needs of the military
PHASE III: Potential opportunities will be for the transition of this technology to commercial sector and/or military advanced programs that would benefit from improved missile tracking and imaging.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Geophysics, geology, and space applications include remote/environmental IR sensing by NASA and civil airspace users.

REFERENCES:
1. HgCdTe photodiodes for IR detection: a review; Reine, Marion B.; AA(BAE Systems); Proc. SPIE Vol. 4288, p. 266-277.
2. Dual-band infrared focal plane arrays; Rogalski, Antoni; AA(Military Univ. of Technology); Proc. SPIE Vol. 4340, p. 1-14, 16th International Conference on Photoelectronics and Night Vision Devices, Anatoly M. Filachev; Ed.; 11/2000
3. Simultaneous MW/LW dual-band MOVPE HgCdTe 64x64 FPAs; Reine, Marion B.; Hairston, Allan W.; O'Dette, P.; Tobin, Stephen P.; Smith, F. T.; Musicant, B. L.; Mitra, Pradip; Case, F. C.; AA(Lockheed Martin IR Imaging Systems) AG(Lockheed Martin Vought Systems); Proc. SPIE Vol. 3379, p. 200-212, Infrared Detectors and Focal Plane Arrays V, Eustace L. Dereniak; Robert E. Sampson; Eds.; 7/1998

KEYWORDS: multicolor, multispectral, metereology, miniature, sensors, filters, LWIR, FPA, IR detectors

MDA02-050 **TITLE**: Multi Sensor Fusion

TECHNOLOGY AREA: Sensors

ACQUISITION SPONSOR: MDA/AC

OBJECTIVE: Develop multi-sensor fusion techniques and algorithms

DESCRIPTION: Missile defense target discrimination may be improved by using sensors from different phenomenology regimes, such as radar and electro-optical sensor measurements, or multiple aspect angles. This effort will develop techniques to fuse data from multiple sensors as a means of improving missile defense capabilities.
PHASE I: Identify a technique which could be used fuse data from multiple sensors, either multiple phenomenologies or multiple aspect angles.
PHASE II: Refine the technique, potentially into a prototype algorithm (such as a MATLAB version), which can be tested using realistic digital simulations or actual target signatures.
PHASE III: Prepare the technique for transition to the missile defense system developer and support the transition to the system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This work could be applied to the medical field where different sensors are used in diagnosing problems.

REFERENCES: None

KEYWORDS: fusion; multi-sensor; tracking; discrimination; identification; algorithm