



Air Armament 2020 Directed Energy

2007 October 11 • NDIA Air Armament Symposium

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Director
Directed Energy Directorate





Focused Long Term Challenges

AFRL Investment Strategy

- 1. Anticipatory Command, Control and Intelligence (C2I)**
- 2. Unprecedented Proactive Surveillance and Reconnaissance (S&R)**
- 3. Dominant Difficult Surface Target Engagement/Defeat**
- 4. Persistent and Responsive Precision Engagement**
- 5. Assured Operations in High Threat Environments**
- 6. Dominant Offensive Cyber Engagement**
- 7. On-demand Theater Force Projection, Anywhere**
- 8. Affordable Mission Generation and Sustainment**



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Mission and Vision

AFRL/Directed Energy Directorate

Unleash the Power of Directed Energy



*Lead the discovery, development, and delivery
of directed energy science and technology for National Security.*



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Core Technology Competencies (CTC)

AFRL/Directed Energy Directorate



Lasers



Advanced Optics



Millimeter Waves



High Power Microwaves



Modeling and Simulation Studies



Target Vulnerability Assessments



*Electro-Optical Images
Computer Databases*



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The Near- to Far-Term Reality

Directed energy is going to have tactical and strategic implications that today we're probably not even realizing.

**Dr. Mark Lewis
Chief Scientist
U.S. Air Force
2007**



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AFRL/Directed Energy

Game Changers



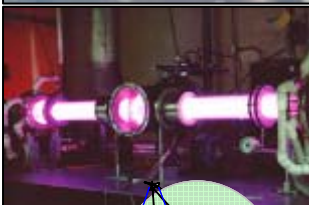
High Power Microwave (HPM) Counter-Electronics



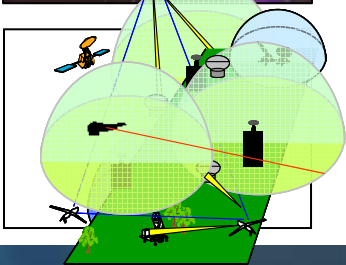
Airborne Active Denial Technology



Tactical Airborne High Energy Laser



Laser Countermeasures



Directed Energy Shield



Directed Energy 2020 Paradigm

High Power Microwave (HPM) Counter-Electronics



Enables attack on high value electronic targets with minimal collateral damage; virtually eliminating high post-conflict reconstruction costs!!!!

Warfighter Benefits

Unique capabilities that disrupt through destroy:

- Command, Control, and Communications (C³) Centers
- Integrated Air Defense Systems (IADS)
- WMD Production Facilities
- Cyber War Targets
- Enemy Infrastructures



Directed Energy 2020 Paradigm

High Power Microwave (HPM) Counter-Electronics



\$75 Mil; 60-Months; BAA
**High Energy Research and
Applications (HERA)**

Enabling Technologies

- Control system ability to orient the radiating aperture to illuminate the target
- Dual-pulse HPM device
 - Interface to delivery aircraft systems
 - Seek Eagle process for munition drop
- Platform mechanics
- Validating and assessing effects



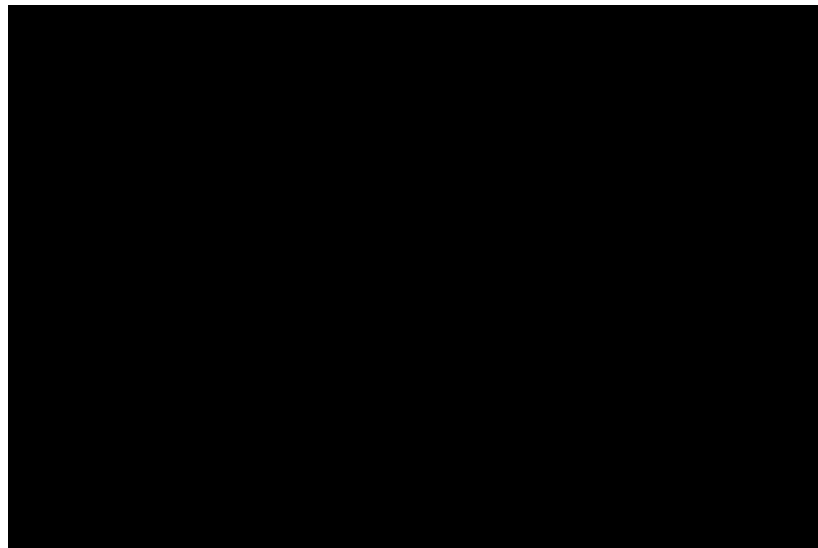
Directed Energy 2020 Paradigm

Airborne Active Denial Technology (AADT)

Warfighter Benefits

Non-lethal force option

- Compatible firing orbits allows seamless transition between lethal and non-lethal force
- Viable in constrained and urban environments
- Supports
 - Rescue operations
 - Airfield and/or facility protection
 - Crowd control

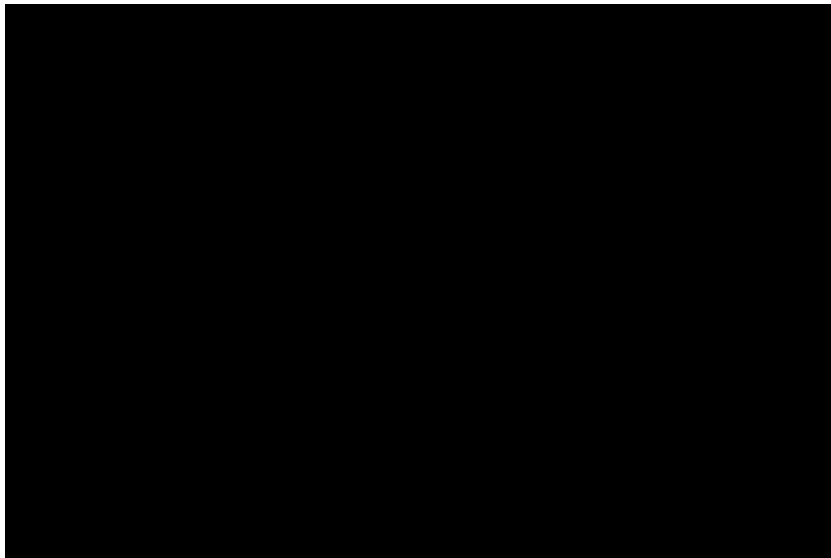


*Basic biological effect :
Millimeter wave energy causes
intense thermal reaction on
outer 1/64" of skin.*



Directed Energy 2020 Paradigm

Airborne Active Denial Technology (AADT)



\$75 Mil; 60-Months; BAA
**High Energy Research and
Applications (HERA)**

Enabling Technologies

- High Power Millimeter Wave Transmitter
 - Projects beam
 - Line of sight; Speed of light
- 2.5MW high specific power millimeter wave source
- High airborne prime power
- Thermal aircraft integration

**Paradigm Shift in
Airborne Weaponry**



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Tactical Airborne High Energy Laser



Intended missions include vehicle disable and/or stop, urban conflicts, and infrastructure disruptions

Warfighter Benefits

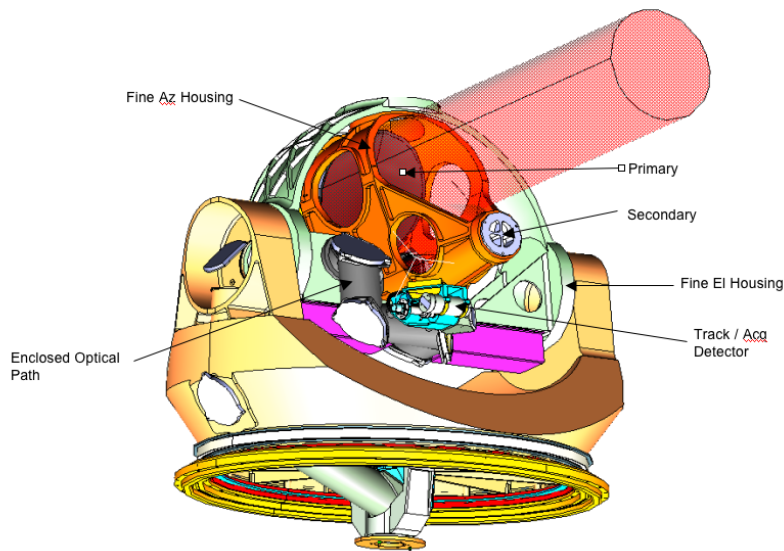
Ultra-precision target engagement:

- Speed-of-light weapon
- Covert operation
- Scaleable effects from degrade to destroy
- Minimal collateral damage



Directed Energy 2020 Paradigm

Tactical Airborne High Energy Laser



\$49 Mil; 60-Months; Open BAA
Laser FAST

Enabling Technologies

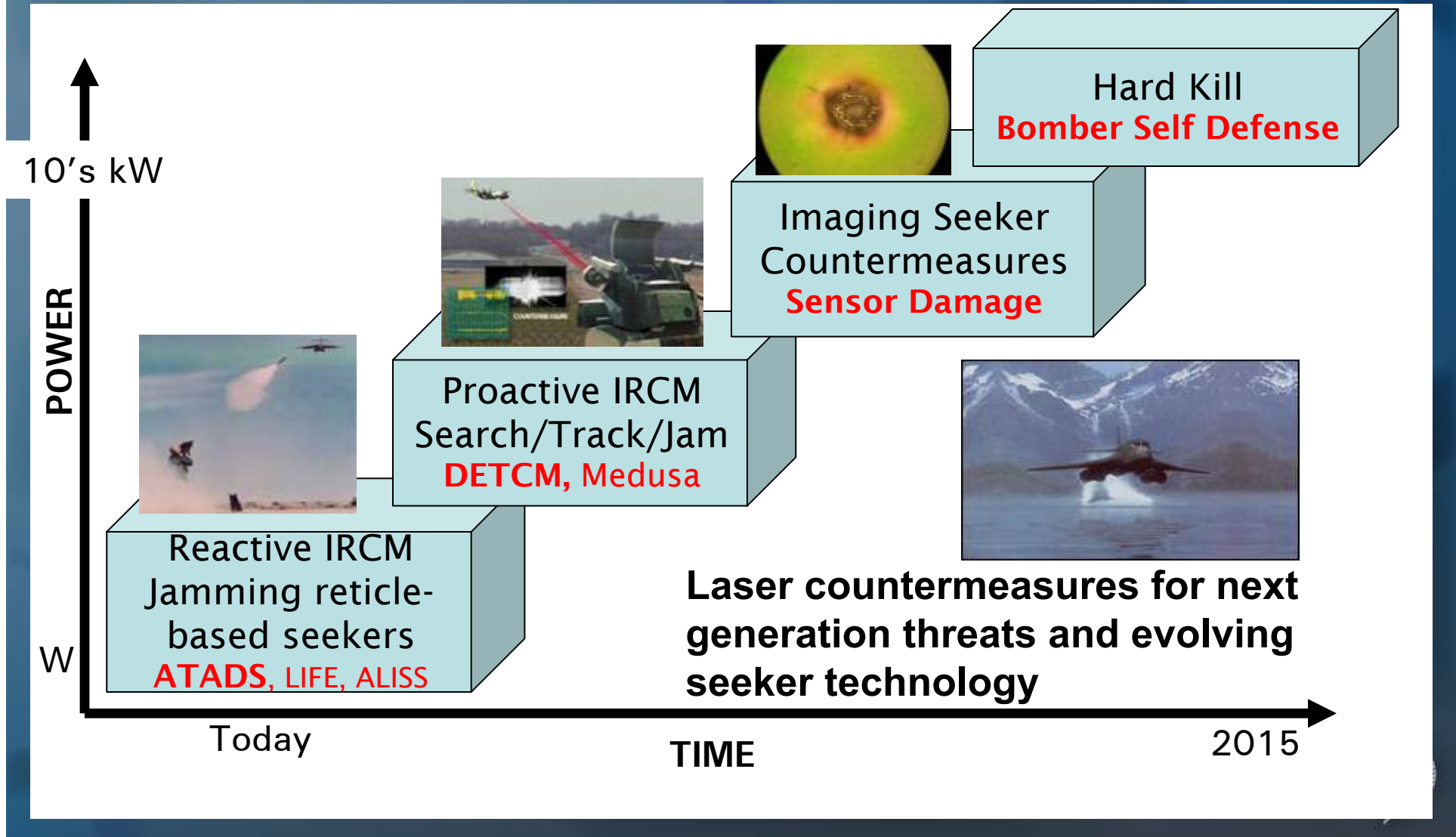
- Tactical beam control
- Multiple efficient, lightweight laser device concepts
 - Solid State Lasers (SSL)
 - Fiber Lasers
 - Thin-disk Solid State Lasers
 - Next generation gas lasers
- Adaptive optics
- Aerodynamic flow control
- Target vulnerability assessments



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Laser Countermeasures Next Generation Threats





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Laser Countermeasures Next Generation Threats

Benefit to warfighter:

Survive the Fight



Directed Energy 2020 Paradigm

Laser Countermeasures Next Generation Threats



Enabling Technologies

- Analytical modeling and experimental initiatives
- Effects/lethality assessments
- Infrared countermeasure (IRCM) sources
- Long wavelength search/track sources
- Jamming and damaging sources
- Beam director developments



Directed Energy 2020 Paradigm

Directed Energy Shield



Layered protection system using active threat detection to detect, identify, and engage threats with beams of energy

Warfighter Benefits

Family of Systems provides:

- Multiple kill and defense opportunities
- Different kill and defense opportunities
- Interoperability between lethal and non-lethal weapons
- Flexibility of results
- Synergism between services



Directed Energy 2020 Paradigm

Directed Energy Shield



Enabling Technologies

- Combined lethal/non-lethal DE and kinetic defenses
- Low cost, light weight, non-obtrusive sensing to assess current condition
- Autonomous C2 linking sensors to ground-based and air-based shooters
- High energy laser sources and effects



Near-Term Contract Opportunities

Description	Solicitation/ Award Date	Total Value	POC
<u>Fiber Amplifiers:</u> Design and develop 50W fiber amplifiers for 1550 nm source	BAA: 01 Oct 07 Proposals Due: 16 Nov 07	\$500K	Dr. Tom Ferrell --RDSE tom.ferrell@kirtland.af.mil (505) 846-5001
<u>Improved Tracking Mirrors:</u> Design and develop a high-performance tracking mirror capable of 1 kilohertz bandwidth and having a 3 inch clear aperture mirror and a surface flatness of $\lambda/20$	BAA: 11 Jan 08 Proposals Due: 25 Feb 08	\$160K	Dr. Tom Ferrell – RDSE tom.ferrell@kirtland.af.mil (505)846-5001
<u>Telescope:</u> Design and develop a one meter primary, on-axis Cassegrain, azimuth/elevation mount telescope for use in laser propagation and turbulence sensing experiment	RFP Issue: 05 Oct 07 Proposals Due: 20 Nov 07	\$8M	Capt Michael Walter -- RDS michael.walter@kirtland.af.mil (505) 846-5036



Near-Term Contract Opportunities

Description	Solicitation/ Award Date	Total Value	POC
<u>High energy Research and Applications:</u> Design and develop electro-magnetic sources capable of higher peak power, higher repetition rates, coupled to antenna systems with greater gain and power handling capability, and are driven by lighter, more compact pulsed power systems	BAA Issue: 1 st Qtr FY 08	\$75M	Jon Hull -- RDHP jon.hull@kirtland.af.mil (505) 846-2651
<u>Laser FAST:</u> Design and develop creative and innovative solutions to continue the discovery, development, and delivery of laser technologies for our air and space warfighting forces	FY 08/ Call will be placed against this open BAA as required in the next 60-months	\$49M	Eric Lindom -- RDL eric.lindom@kirtland.af.mil (505) 846-2244



Near-Term Contract Opportunities

Description	Solicitation/ Award Date	Total Value	POC
<u>Laser Effects, Vulnerability, Research (LEVR):</u> Provide analytical modeling and experimental tasks to accurately predict the effects of lasers on various threat targets. Enhance current capabilities by developing and improving AFRL's Missile Assessment Center Codes and databases, research the vulnerability of the aforementioned systems and subsystems, and assess the lethality of potential laser weapon concepts against these systems	BAA 07 DE 08 Published: 24 Jul 07 Call 0001 Issued: 23 Aug 07	\$49M	Dr. Nicholas Morley -- RDLE nicholas.morley@kirtland.af.mil (505) 846-0805



Small Business Innovative Research (SBIR) Opportunities



POCs: Francisco Tapia (505) 846-5021
Ardeth Walker (505) 846-4418

Objectives/Goals

- Stimulate Technological Innovation
- Use Small Business to Meet Federal R&D Needs
- Increase commercialization from Federal R&D Efforts

FY07 Funding \$14M

- | | |
|---------------------------|--------|
| • Phase I | \$2.4M |
| • Phase II | \$8.0M |
| • Phase II Enhancements | \$1.1M |
| • FY06 Phase II Mortgages | \$2.1M |

FY08 Proposed \$14M

- | | |
|------------------------|--------|
| • Phase I Anticipated | \$2.1M |
| • Phase II Anticipated | \$7.5M |

Schedule/Milestones

- Proposals Submitted
 - SBIR Solicitation 2008.1 Jan 08
 - SBIR Solicitation 2008.2 Jun 08
 - SBIR Solicitation 2008.3 Sep 08
- Contracts
 - Phase I/Feasibility \$100k Max
 - Phase II/Prototype \$750k
 - Phase III/Commercialization



Small Business Innovative Research (SBIR) Opportunities

Sample:

DE Topics Solicitation 2007.3 closed in September



<http://www.acq.osd.mil/osbp/sbir/>

Small companies retain the intellectual property rights to technologies they develop under these programs.

- Adaptive Optics Compensation In Deep Atmospheric Turbulence
- Cryogenic High Power Laser Pump Diodes
- Integrated Wide-Bandgap Semiconductor Photoconductive Switch With A Terahertz Antenna
- Non-Linear Transmission Line Microwave Source
- Intracavity Beam Control In Laser Resonators
- Solid State Switch For High Voltage Sub-Microsecond Pulsed Power
- High Average Intensity High Repetition Rate Short Pulsed Neutron Source



Small Business Innovative Research (SBIR)

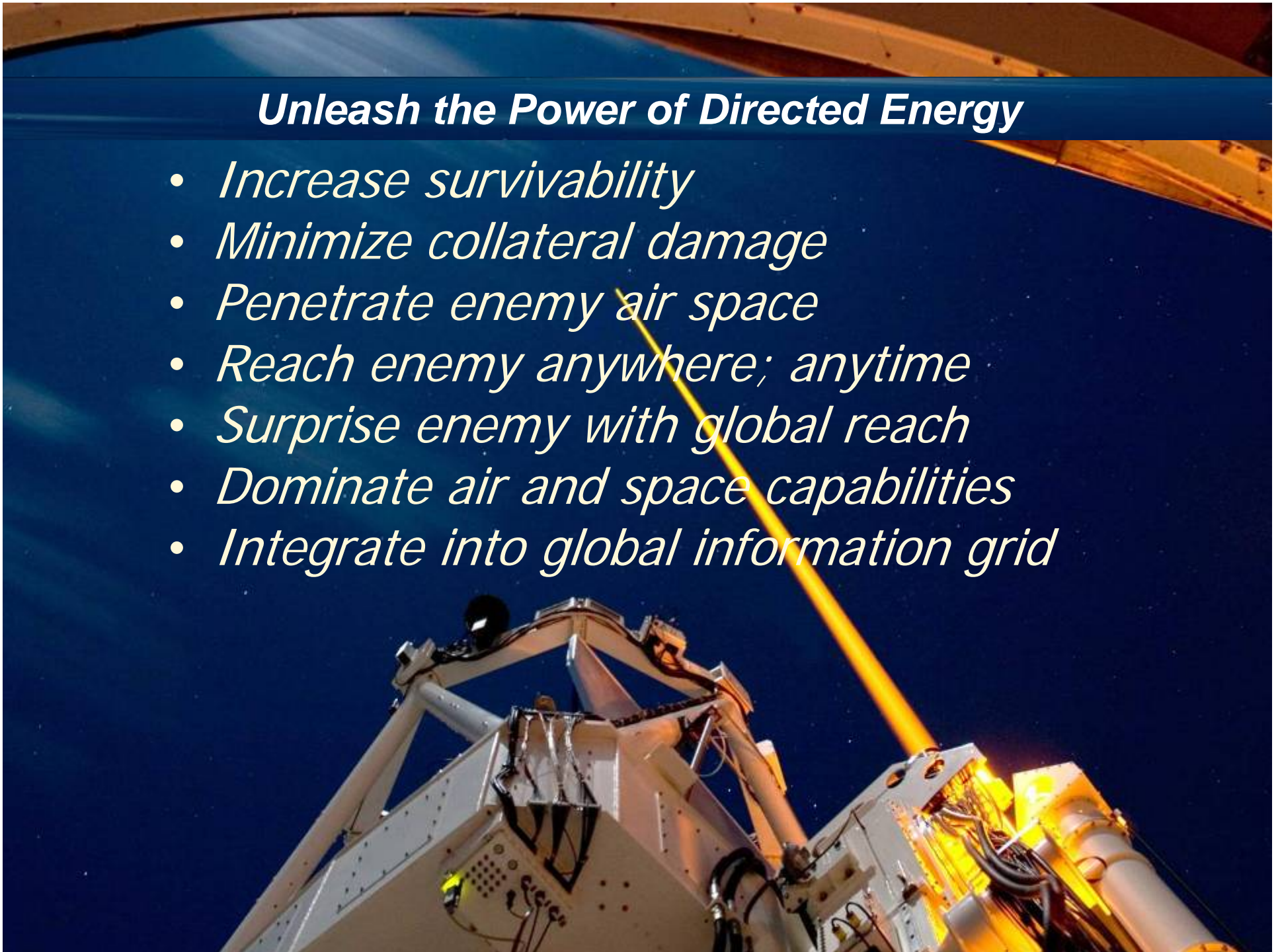
FY08 Potential DE SBIR Topics

Topic #	SBIR Titles 2008.1
AF081-001	3D Magnetic Field Modeling
AF081-002 B/U #1	Atmospheric Characterization for Laser Propagation

Solicitation 2008.3	
Topic call	September 2007 – April 2008
RD internal topics	9 topics anticipated
Solicitation	19 July – 19 September 2008

Unleash the Power of Directed Energy

- *Increase survivability*
- *Minimize collateral damage*
- *Penetrate enemy air space*
- *Reach enemy anywhere; anytime*
- *Surprise enemy with global reach*
- *Dominate air and space capabilities*
- *Integrate into global information grid*





DE has the Power to Change the face of military conflict.

***There is nothing more difficult to take in hand,
more perilous to conduct, or more uncertain in its
success than to take the lead in the introduction
of a new order of things.***

Niccolo Machiavelli, Italian Political Philosopher, 1469-1527



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