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AFRL/Directed Energy

8 September 2005 Update

Directed Energy Directorate
Air Force Research Laboratory
Kirtland AFB, New Mexico

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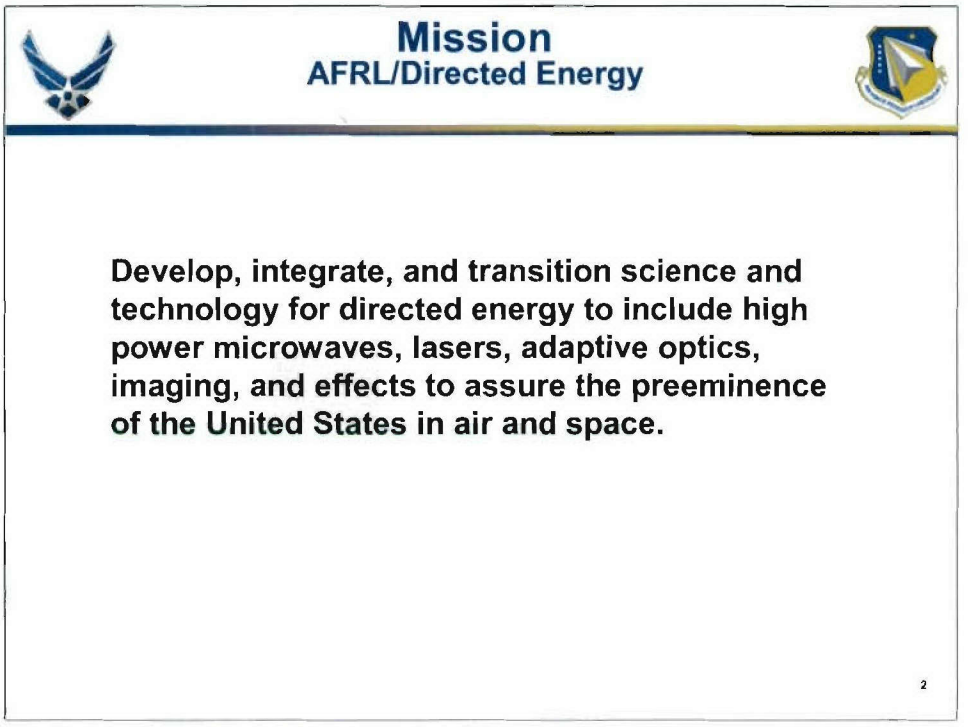
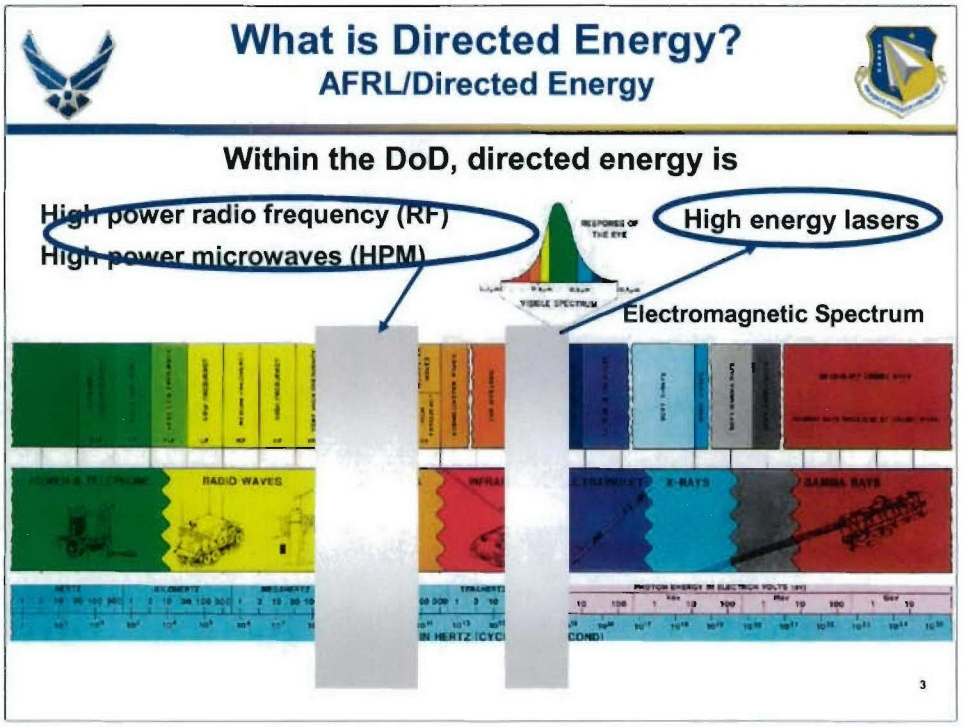
The Air Force Research Laboratory's Directed Energy Directorate develops high-energy lasers, high-power microwaves, and other directed energy technologies for the United States Air Force and the Department of Defense.

We are also involved with advanced optics and imaging technologies to improve the nation's ability to precisely project these directed energies at the speed of light anywhere, at any time and with graduated intensity.

www.de.afrl.af.mil



The Air Force is developing directed energy technologies and systems because the advantages offered are potentially profound. These advantages include near-instantaneous target effects, high-precision low collateral damage strike capabilities (including potentially surgical effects with laser weapons), nonlethal force application and target effects with high power microwave (HPM) and active denial technologies (ADT), ultrahigh bandwidth and ultrasecure communications with lasers, and significantly increased remote sensing capabilities.



Our technology falls within the electromagnetic spectrum

Both technologies offer

Speed-of-light Delivery

Graduated effects from deny to destroy

Element of surprise with speed-of-light delivery

Element of confusion with graduated effects

Laser illumination

-- fear as chance there is a gun connected to scope

ADS (active denial systems)

-- again fear since you feel as if your skin is on fire as it penetrates 1/64th of an inch

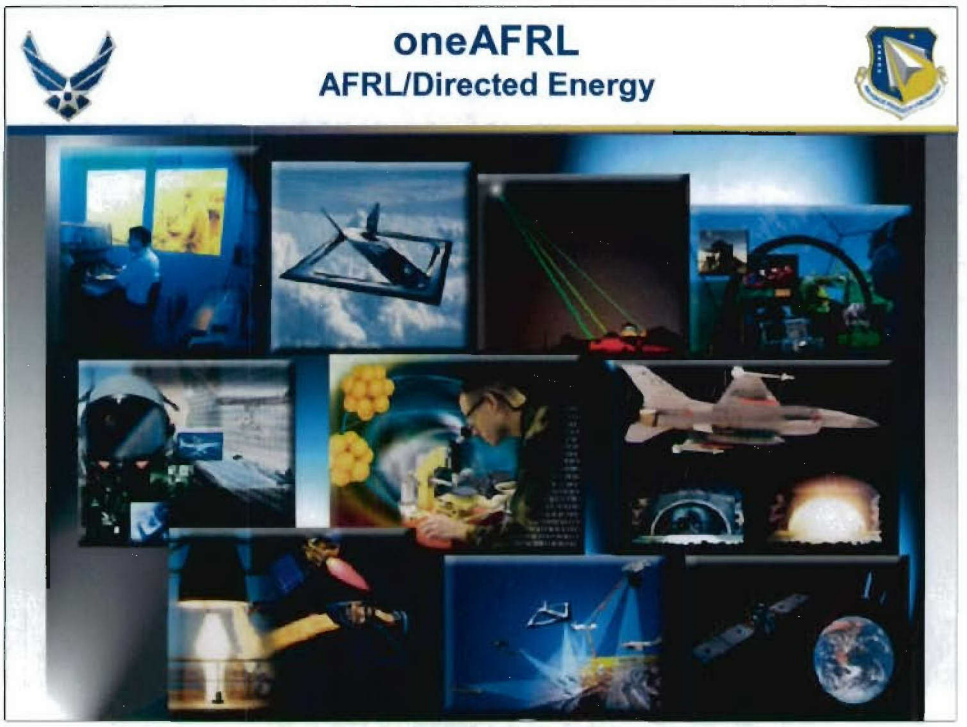
JOKE: Today's electromagnetic spectrum looks different from the first one I saw in grade school – gone with the slide rules

•Speed of Light Delivery
- •Near real-time effects upon trigger pull
- •Impossible to outmaneuver
- •Rapid retargeting

•Precision Engagement
- •Select the target and aim point
- •Minimum collateral damage

•Controlled Effects
- •Graduated effects from deny to destroy
- •Nonlethal human applications

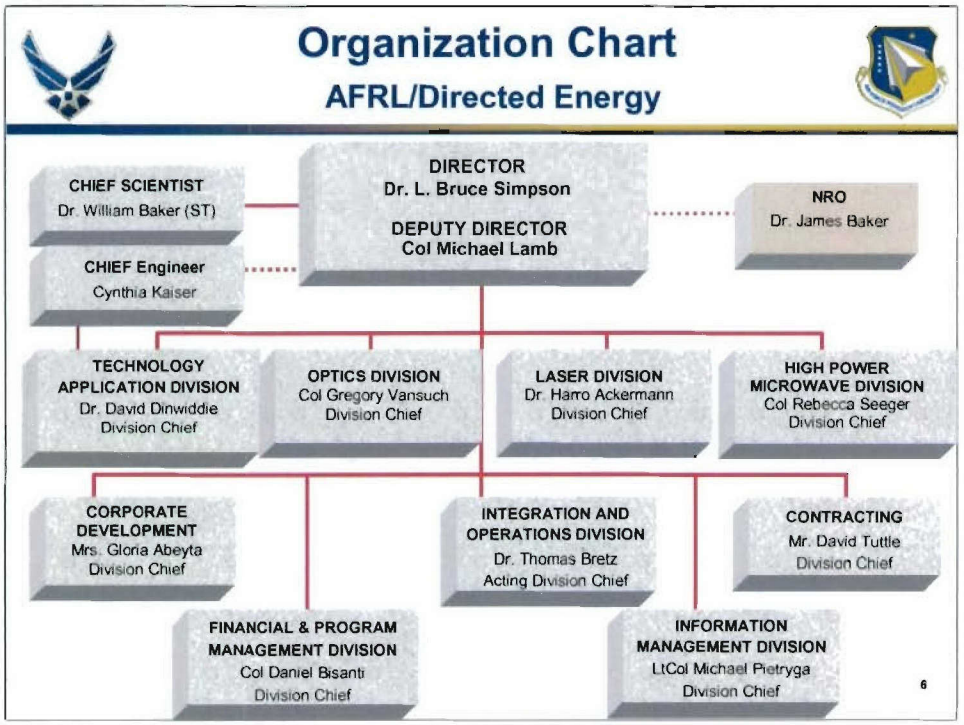
•Logistics Advantages
- •Low cost per shot
- •Deep magazine without shelf-life or stockpile issues
- •Seamless awareness of space objects



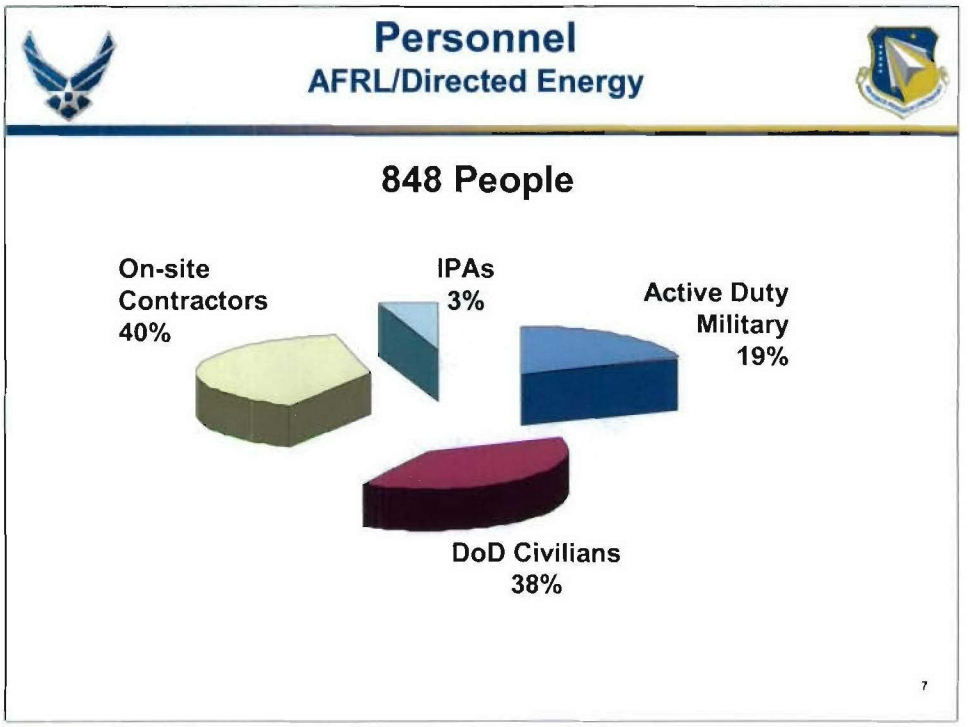
Directed Energy is one of 10 similarly-sized subordinate units that comprise Air Force Research Laboratory, the Department of Defense's largest laboratory, headquartered at Wright-Patterson Air Force Base , Ohio. With approximately 6,000 military and civilian employees at nine bases throughout the United States, Air Force Research Laboratory is responsible for research and technology development in support of the Air Force's future and existing aerospace and space weapons systems.

- Air Force Office of Scientific Research
- Air Vehicles
- Directed Energy
- Human Effectiveness
- Information
- Materials and Manufacturing
- Munitions
- Propulsions
- Sensors
- Space Vehicles

Update when 11th stands up



New Aug 2005 Col Lamb



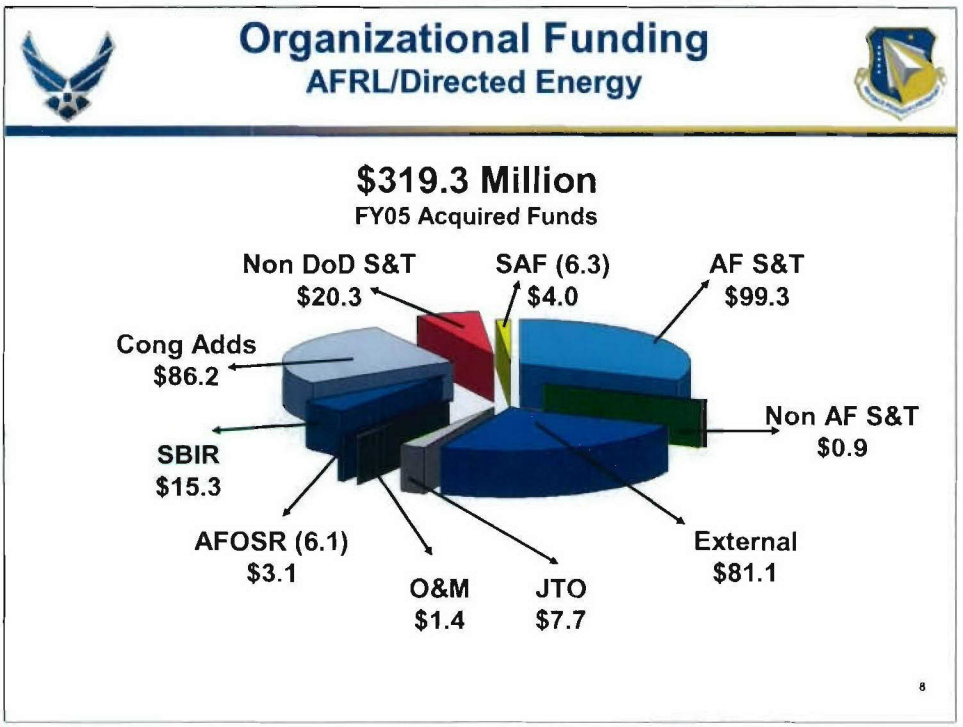
IPA = Intergovernmental Personnel Act

The Intergovernmental Personnel Act provides for the temporary or extended detail of employees from State and local governments, Indian tribal governments, institutions of higher education, qualifying non-profit organizations, Federally Funded Research & Development Centers (FFRDC), etc., to an agency of the Federal Government.

For more information regarding employment at DE, Log on to:

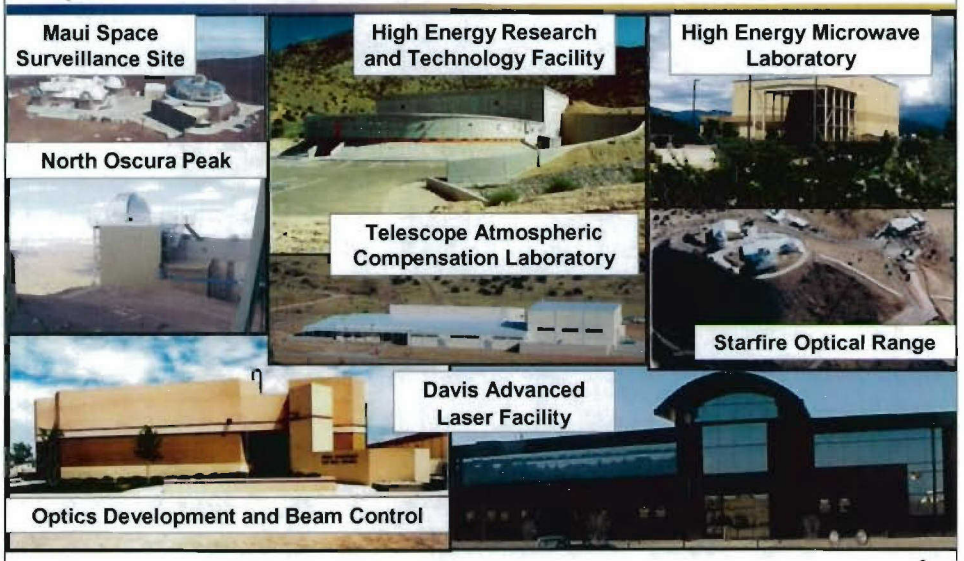
http://www.vs.afrl.af.mil/LabDemo/

OR http://www.usajobs.opm.gov/



AF	Air Force
AFOSR	Air Force Office of Scientific Research
	Directorate of AFRL – 6.1 research (basic research)
Cong Adds	Congressional Additional Funding
	Normally 6.2 and 6.3 research (advanced and applied research)
DoD	Department of Defense
External	Customer Funds
JTO	High Energy Laser Joint Technology Office
O&M	Operation and Maintenance Funds
SAF	Secretary of the Air Force
	Normally 6.3 research (applied research)
S&T	Science and Technology
SBIR	Small Business Innovation Research
	The SBIR Program provides up to $850,000 in early-stage R&D funding directly to small technology companies (or individual entrepreneurs who form a company); http://www.acq.osd.mil/sadbu/sbir/homepg.htm
Non AF S&T	Other services and government agencies

Facilities
AFRL/Directed Energy



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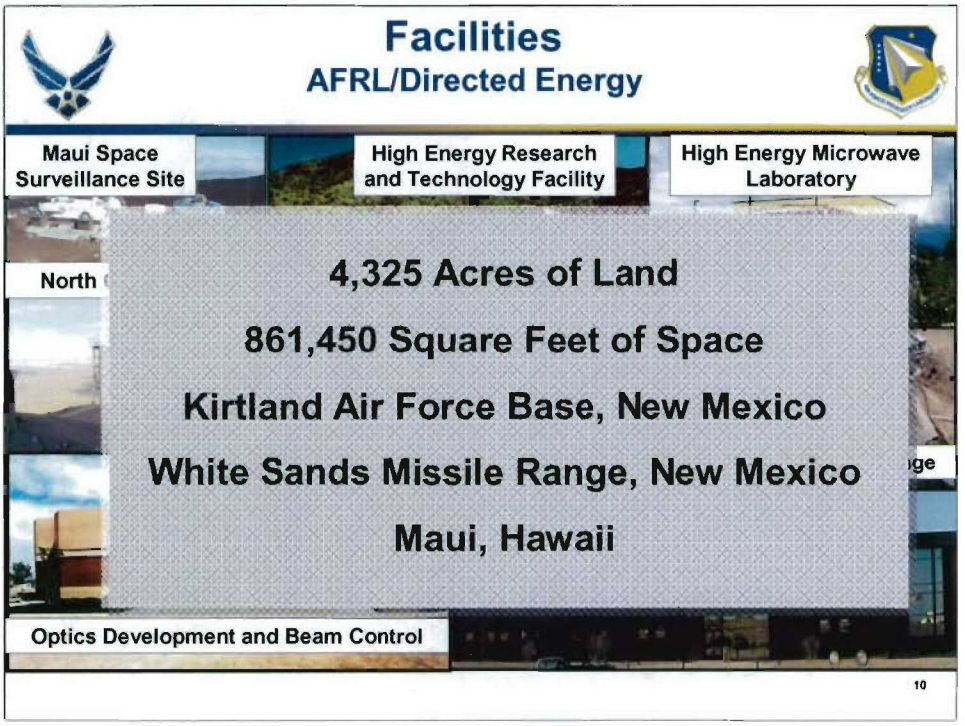
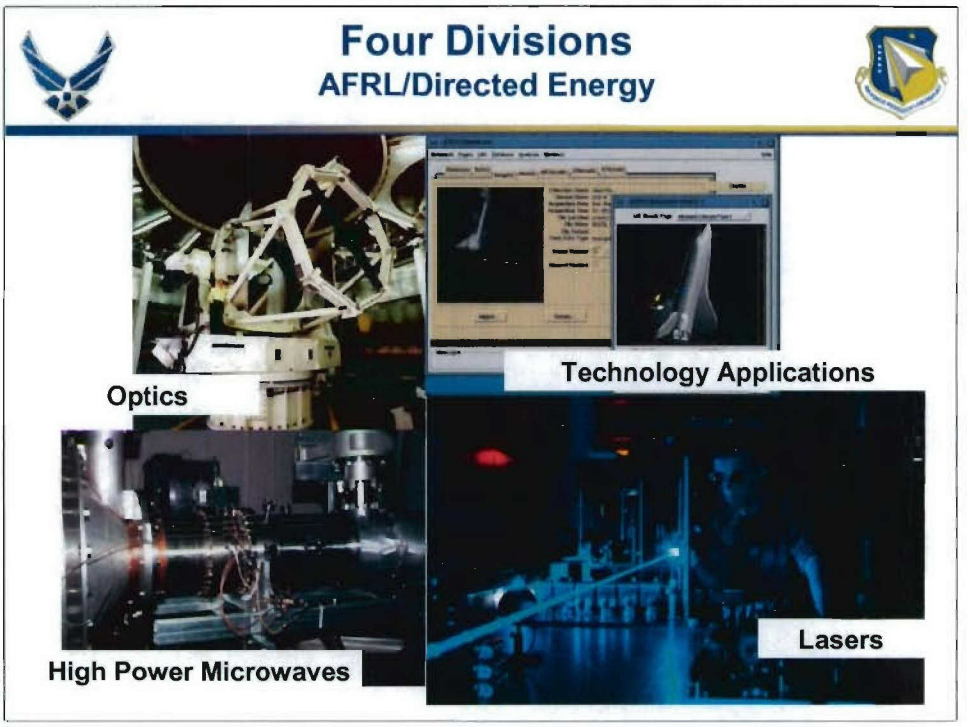

Facilities
AFRL/Directed Energy
Maui Space Surveillance Site
High Energy Research and Technology Facility
High Energy Microwave Laboratory
North
4,325 Acres of Land
861,450 Square Feet of Space
Kirtland Air Force Base, New Mexico
White Sands Missile Range, New Mexico
Maui, Hawaii
Optics Development and Beam Control
10



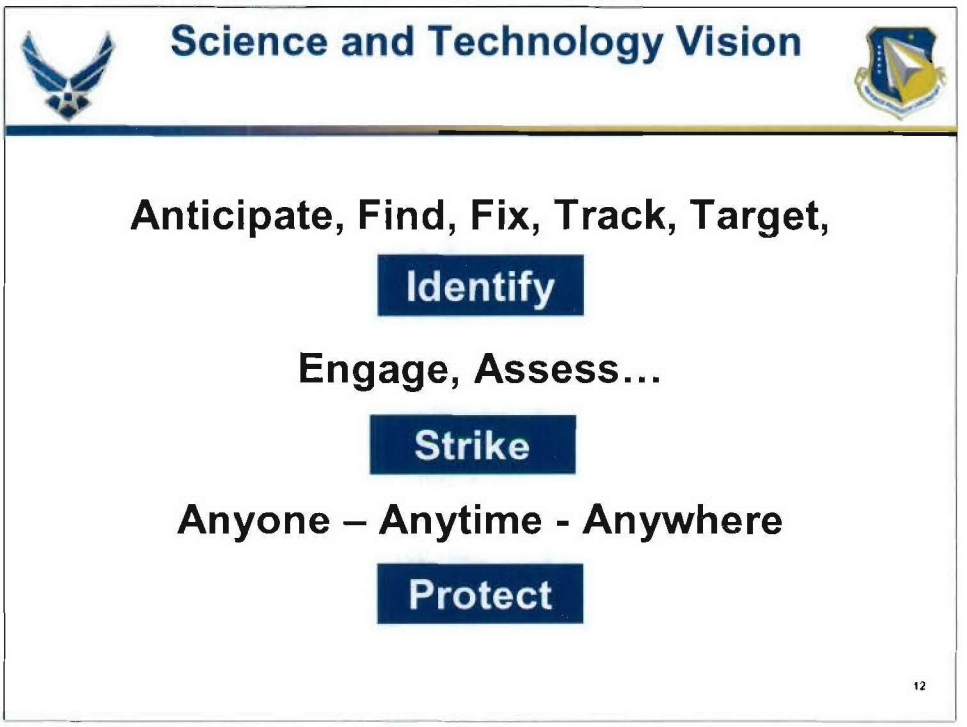
The High-Power **Microwave** Division is the Department of Defense's center of excellence in this area, managing the research and development of high-power microwave technologies, including protection against an aggressor's microwave systems. Systems that can identify weapons concealed inside buildings or turn away attacking troops without using lethal force are among the technologies being worked in this Division.

The **Laser** Division is the United States Air Force's center of expertise for developing high-energy laser systems for U.S. military forces. This Division performs cutting-edge research and development of transformational technologies, concentrating on semiconductor, gas, chemical, and solid-state lasers. An example of the scientific contributions made by Division scientists is the invention of the Chemical Oxygen-Iodine Laser, a high-power laser for the Airborne Laser, used to destroy attacking ballistic missiles shortly after being launched.

The **Optics** Division is conducting research to improve optical and imaging systems – improving the nation's ability to view objects in space – as well as developing technologies to accurately put high-energy laser energy on target. The Division operates the largest and most sophisticated telescope facilities in the Defense Department, conducting experiments at the Starfire Optical Range on Kirtland Air Force Base, North Oscura Peak on White Sands Missile Range, and at Hawaii's Maui Space Surveillance Site.

The Technology **Applications** Division concentrates on taking the technologies being developed by the other divisions and transitioning that research to other warfighting organizations. This division monitors potential Department of Defense needs and develops opportunities for transferring directed energy systems to front-line Defense Department units.

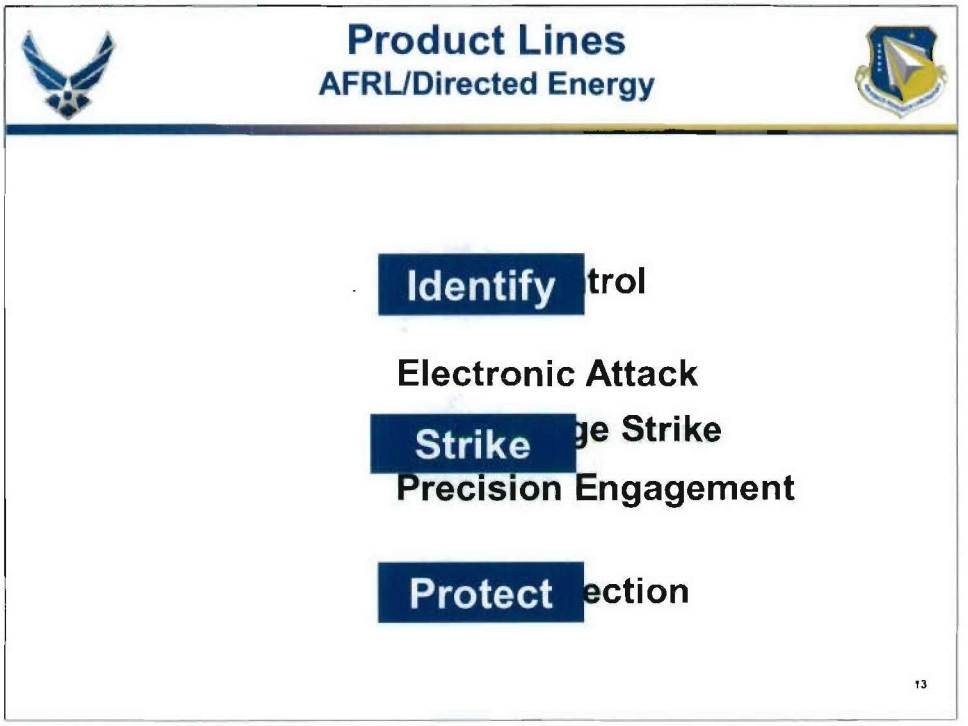
Find out more from our web site: http://www.de.afrl.af.mil/



S&T vision lines up with the Air Force core competencies (which follow):

- Aerospace Superiority
  - The ability to control what moves through air and space
  - …**ensures freedom of action.**
- Information Superiority
  - The ability to control and exploit information to our nation's advantage
  - …**ensures decision dominance.**
- Global Attack
  - The ability to engage adversary targets anywhere, anytime
  - …**holds any adversary at risk.**
- Precision Engagement
  - The ability to deliver desired effects with minimal risk and collateral damage
  - …**denies the enemy sanctuary.**
- Rapid global Mobility
  - The ability to rapidly position forces anywhere in the world
  - …**ensures unprecedented responsiveness.**
- Agile combat Support
  - The ability to sustain flexible and efficient combat operations
  - …**is the foundation of success.**

FROM America's Air Force Vision 2020
http://www.af.mil/library/posture/vision/vision.pdf



In 2004, DE aligned our efforts into products that support the S&T/AF visions

- Space Control
- Electronic Attack
- Long Range Strike
- Precision engagement
- Force Protection

DE will change the face of military conflict.

Directed energy technologies can fulfill a wide range of warfighter needs.

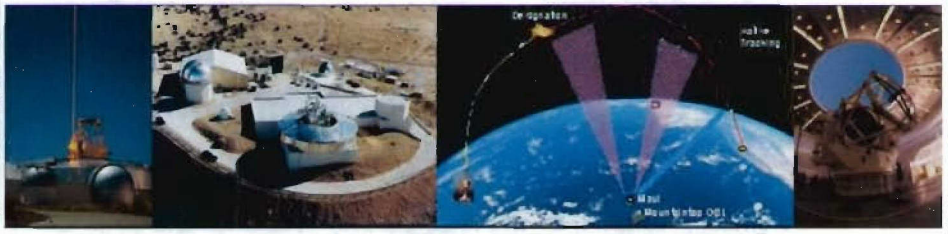
Defensively they can be used to protect our high value military assets.

Offensively, they can be employed to strike at the speed of light with little or no collateral damage.

Directed energy technologies can also be used to provide high resolution imaging and sensing capabilities.

Space Control
AFRL/Directed Energy

Provide rapid knowledge of space situational awareness (SSA) for the combatant commander to ensure freedom of action in space



15

DE Space Control lines up with the Air Force core competencies:

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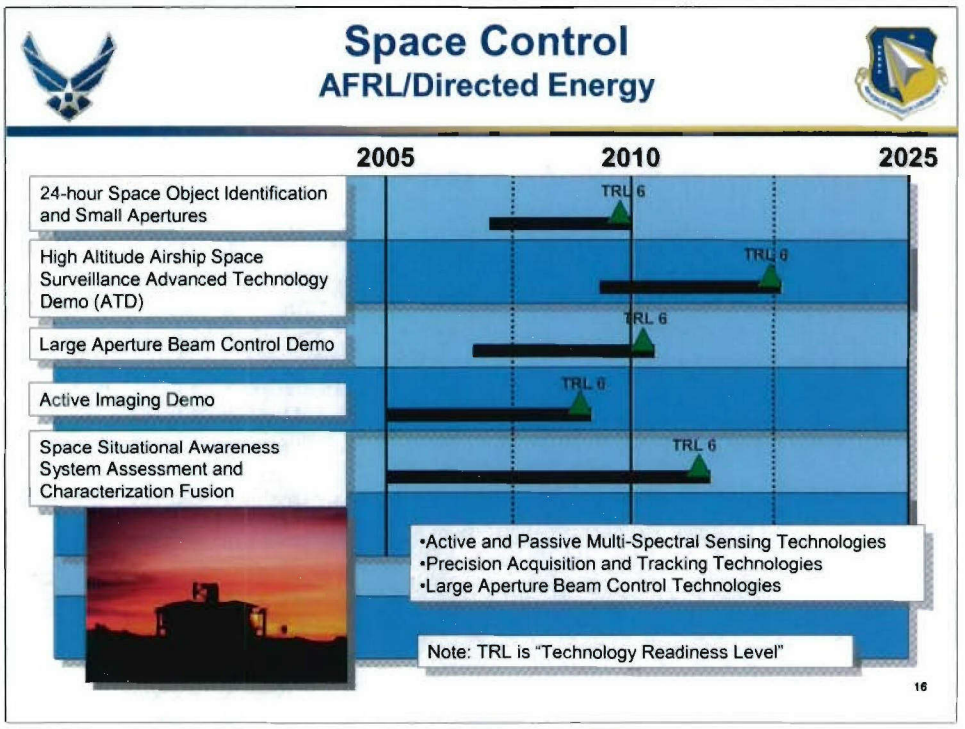

•Provide high resolution imagery of near earth and deep space objects

•Detect, identify, classify, and track large and small space objects continuously

•Enable counterspace operations

•Provide space intelligence, surveillance, reconnaissance and environmental information to the combat commander

•Obtain global coverage for space situational awareness

•Enable freedom of action for US space assets

NOTE:

TRL stands for Technology Readiness Level

Ranges from 1 to 9

Typically TRL 6 is an exit point from AFRL

Time Line is not to scale nor is it linear

dotted line represents the middle between the two dates

Electronic Attack
AFRL/Directed Energy

Disrupt adversaries' critical military and infrastructure electronics and communications equipment with little to no collateral damage

17

DE Electronic Attack lines up with the Air Force core competencies :

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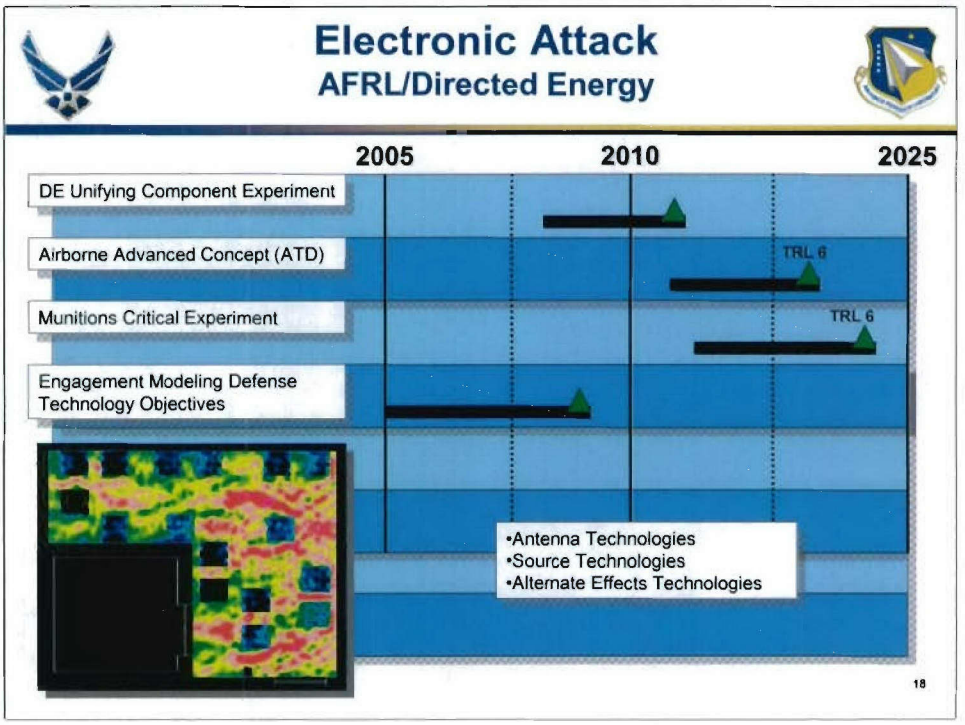

Technologies used for EA are high powered microwaves and infrared energies.

•Develop more efficient and compact high power microwave (HPM) sources

•Assess lethality through wargaming, modeling and simulation scenarios

•Complete studies on HPM target effects and military utility

•Incorporate HPM technology into satellite self-protection

Long Range Strike
AFRL/Directed Energy

Identify, communicate and attack time critical targets anytime; anywhere

18

DE Long Range Strike lines up with the Air Force core competencies:

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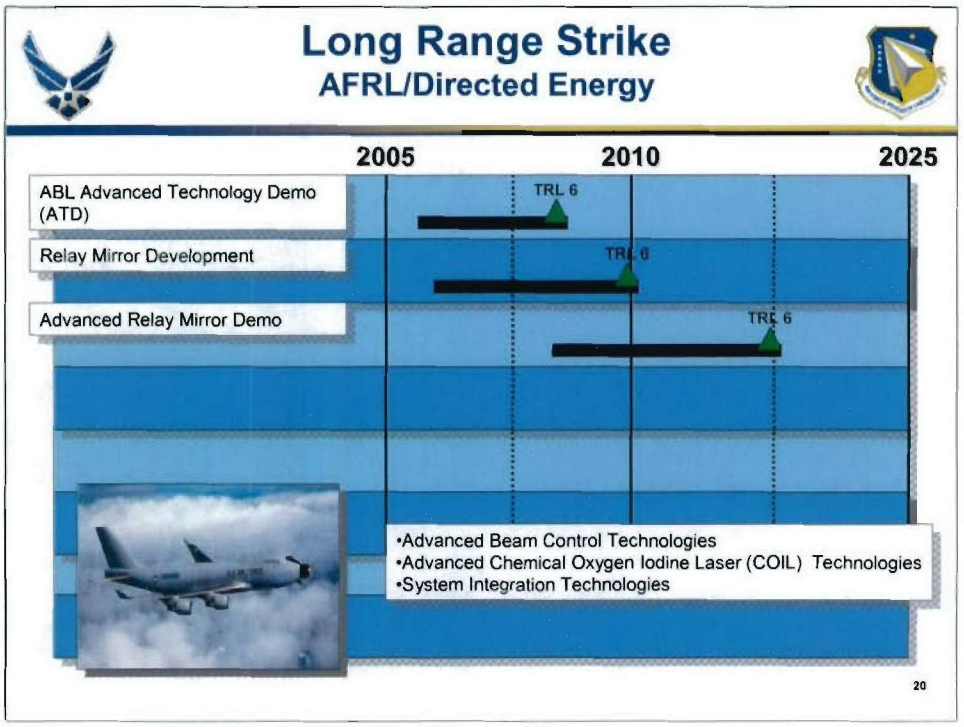

•Arm aircraft operators with ability to destroy ballistic missiles in their boost phase with high-energy airborne lasers (Main purpose of the Airborne Laser (ABL)

•Become more fuel efficient to increase range of ballistic missile kills

•Increase range of protection of ground forces with airborne laser's advanced beam control

•Cover more ballistic missile launch locations

•Incorporate advance long range sensor systems with high altitude relay system's optical telescopes for very high resolution imagery of desired targets

DE Precision Engagement lines up with the Air Force core competencies of:

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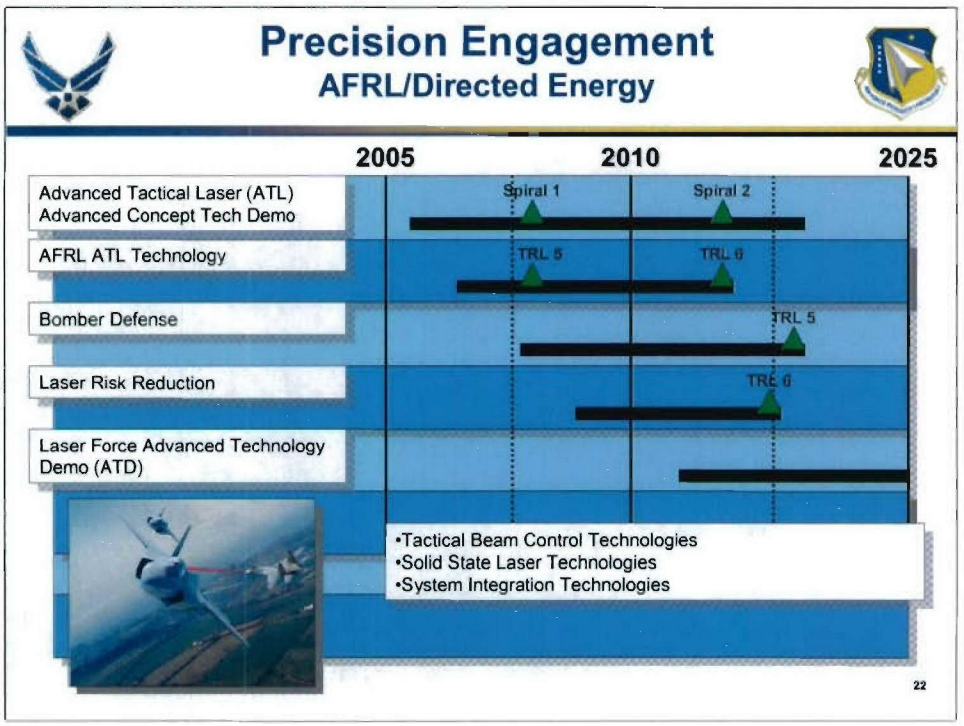

The advanced tactical laser will be capable of projecting laser power from airborne tactical platforms and could be used to provide a wide range of effects. Biggest challenges are in laser power scaling, thermal management, and advanced beam control for tactical engagement scenarios

We're working towards

•Cue and prosecute critical emerging time sensitive targets with self-contained hard-kill capability

•Improve mission efficiency with reduced dwell time, increased range and improved field of regard using advanced beam control technologies

•Increase warfighter capability with improved reliability, reduced costs, expanded target set, increased range and lightened package of solid state laser weaponry

•Transfer Advanced Tactical Laser technology to other platforms and missions increasing combat effectiveness

Force Protection
AFRL/Directed Energy

Protect U.S. Forces with directed energy shields and non-lethal weaponry to minimize casualties and reduce collateral damage

23

DE Force Protection lines up with the Air Force core competencies of:

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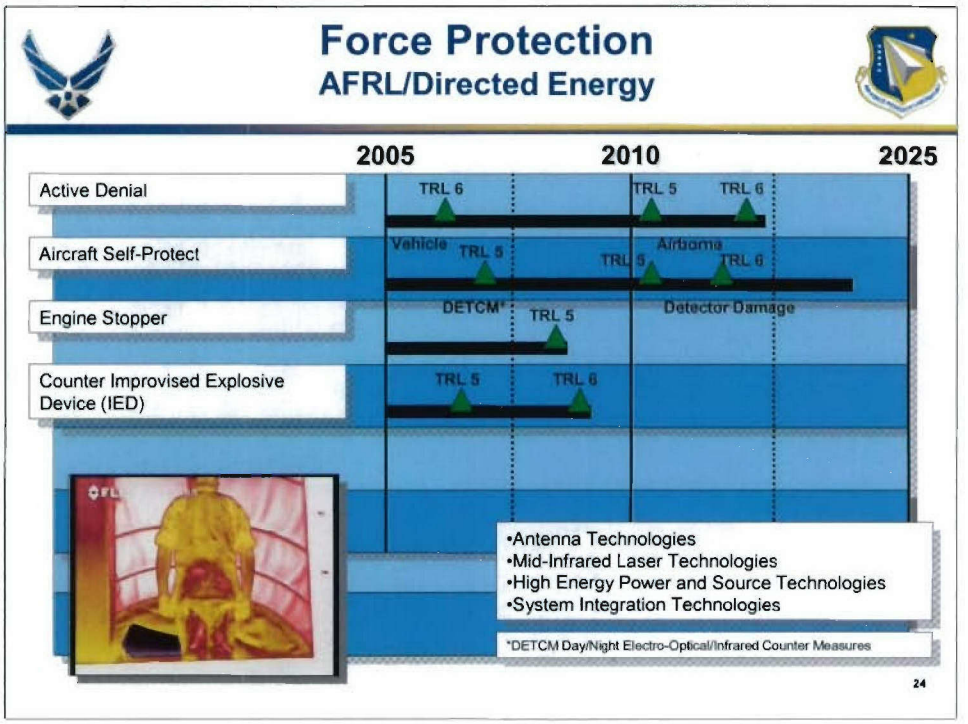


With force protection we are working towards

Detecting threats before they are launched

Providing options to combat commanders

to avoid, deny or counter threat

Securing situational analysis for our aircrew

Basically we are

Increasing survivability of our troops

•Transition ground based active denial technology to Electronic Systems Center for battlefield integration

•Design active denial technology for airborne countermeasures enhancing ability to defeat anti-access strategies

•Pursue multi function capability of tactical laser technology for aircraft self-protection and defense, non-lethal weaponry, battlefield surveillance, optical imaging, and object detection

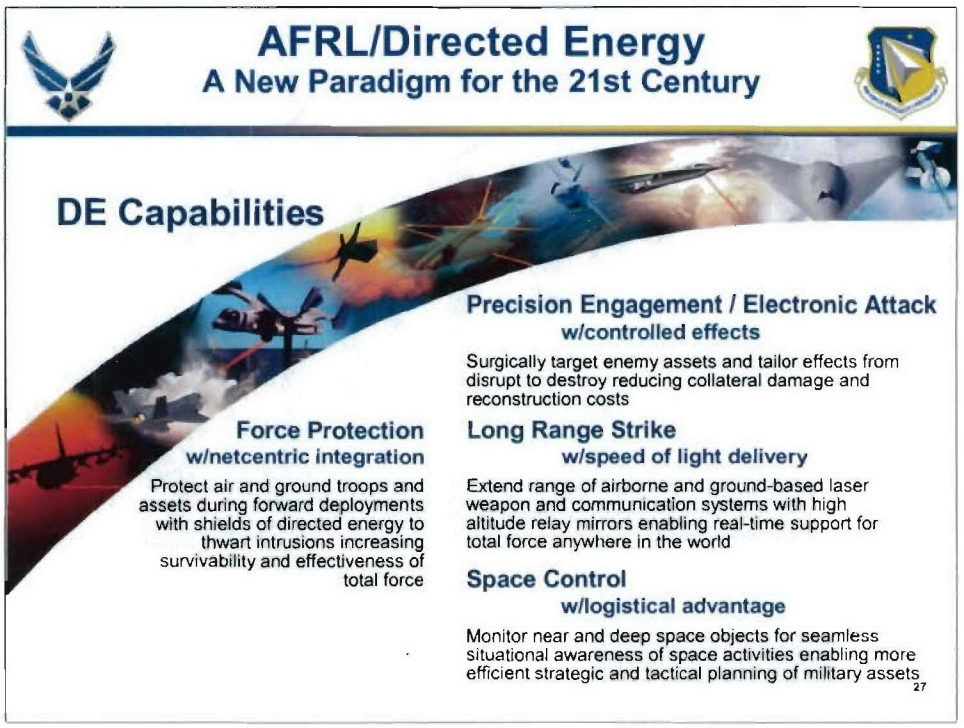
•Integrate technologies for the "engine stopper" and the improvised explosive device (IED) counter measures to the battlefield

Transition Slide

Directed energy is a technology that will revolutionize the way in which we conduct military operations.

In the near term, we are developing technologies that are currently being transitioned to the user.

Overall, the Directed Energy Directorate, in conducting research and development in directed energy, is setting the stage for a revolution in military affairs.



RECAP PAGE technology from previous road maps

Force Protection: Active Denial, Aircraft Self-Protect, Engine Stopper, counter Improvised Explosive Device

Precision Engagement: Advance Tactical Laser, Bomber Defense, Laser Risk Reduction, Solid State Lasers

Electronic Attack: Airborne Advance Concept, Munitions Critical, Engagement Modeling, Antenna Technologies, Alternate Effects

Long Range Strike: Airborne Laser, Relay Mirror, Advance Beam control, Chemical Oxygen Iodine Lasers (COIL)

Space Control: 24-hour Space Object identification, High Altitude Airship Space Surveillance, Large Aperture Beam Control

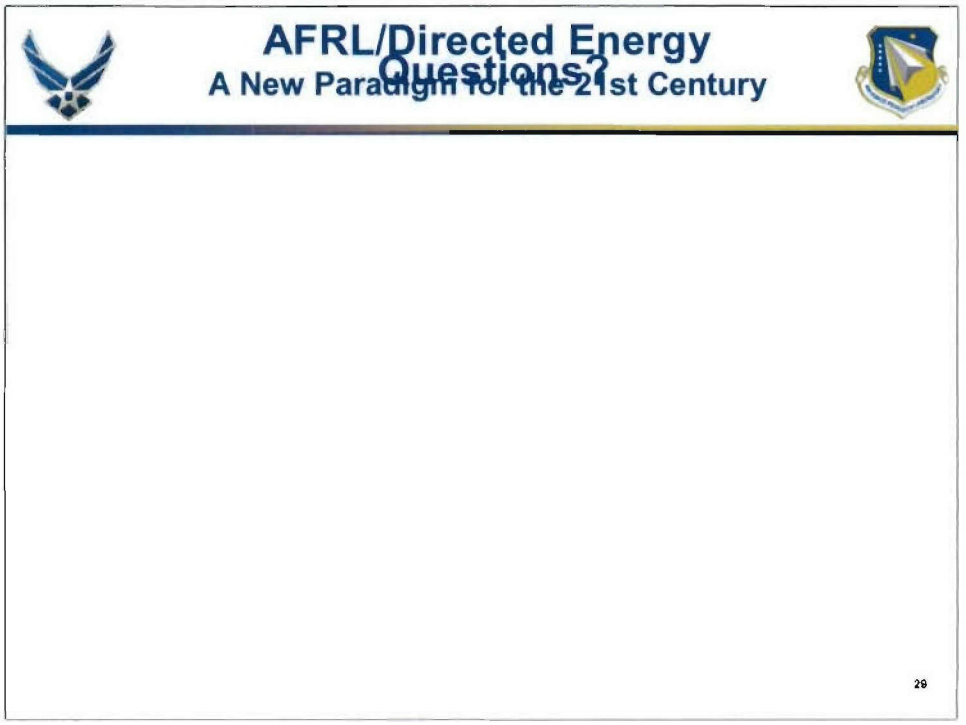
System integration of directed energy technologies

For more information, log on to DE's public website:

www.de.afrl.af.mil

Power Generation and Storage for Airborne Systems
Materials for Efficient Power Generation, Transmission
Thermal Management Issues
Electromagnetic Compatibility/interference
Bioeffects, Safety, and Policy Implications
High Energy Lasers
High Power Microwaves

These are the concerns for DE



JOKES RATED FOR ALL AUDIENCES (Optional)

What gives you power to see through the walls? Windows.

What happens once in a minute, twice in a moment, but never in a thousand years? The letter "M".

Why is 6 afraid of 7? 7 8 9

Why did the scientist install a knocker on his door? To win the nobell prize

Why did Mickey Mouse go to space? To see Pluto.

How did Noah build the ark? He studied ark-eology!

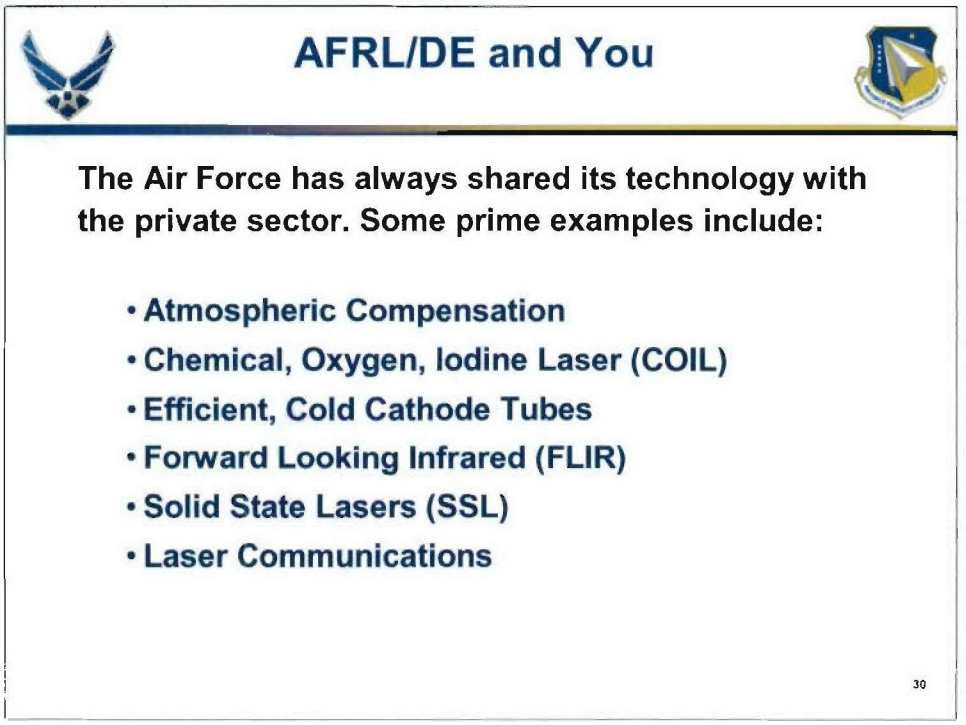
QUOTES RATED FOR ALL AUDIENCES (Optional)

"I have not failed. I've just found 10,000 ways that don't work." *Thomas Alva Edison*

"I have not yet begun to fight!" *-John Paul Jones*

"Touch a scientist and you touch a child." -Ray Bradbury

YOU CAN NATURALLY INTERSPERSE THESE THROUGHOUT YOUR PRESENTATION TO KEEP YOUR AUDIENCE



Technology being developed throughout the Air Force is available for use by other government agencies (technology transition) as well as private industry (technology transfer).

Atmospheric Compensation -- state of the art adaptive optics now used by astronomers to view space – this same technology is also used in advanced LAZIK eye surgery due to its ability to compensate for distortion

Chemical, oxygen, iodine laser (COIL) – laser technology for the Airborne Laser is now used world wide in industrial plants – the COIL easily transfers through fiber optic cable enabling welding and cutting throughout a plant

Efficient, cold cathode tubes – new technology for more efficient and cool operating cathode tubes used commercially for dental and medical x-ray equipment – longer shelf life than current technology (DE needed improved cathode tube technology for our high-power microwave research)

Forward looking infrared (FLIR) – technology enables law enforcement to view through tinted windows (cars and store fronts)

Solid state lasers (SSL) – Laser Medical Pac provides the field paramedic or physician a laser to cut like a scalpel, coagulate bleeding and close wounds with a light-weight (6lbs), rechargeable system – Laser Medical Pen is a 12-inch, one-pound laser that can provide a clean, bloodless incision with the same efficacy as a scalpel or carbon dioxide laser.

Laser communications – line-of-sight, highly secure communications that does not require cabling to transmit

Log on for more information

http://www.de.afrl.af.mil

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