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DEFENCE **R&D** DÉFENSE


Defence R&D Canada – Valcartier
Electro-Optical Warfare Programme

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IEEE Montreal Photonics Society
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 Defence Research and Development Canada Recherche et développement pour la défense Canada

Canada

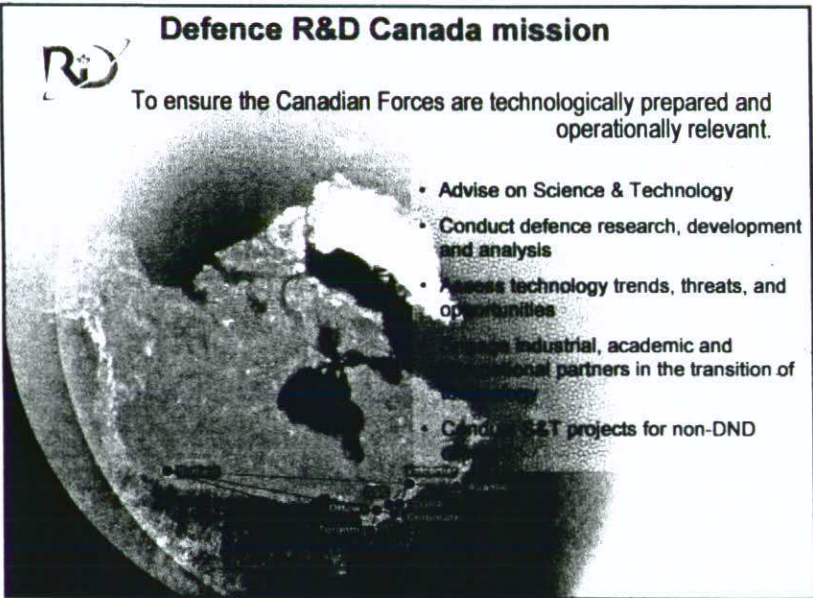
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 **Outline**

- DRDC introduction
- Lasers and optics in modern warfare
- DRDC Valcartier electro-optic warfare section
 - Mission and context
 - Navy Projects
 - Army Projects
 - Air Force Projects

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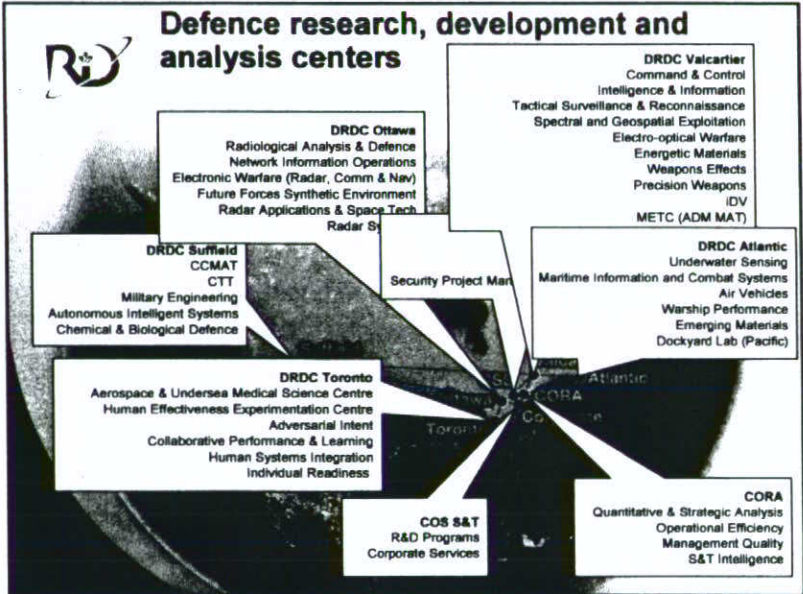
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Defence R&D Canada mission

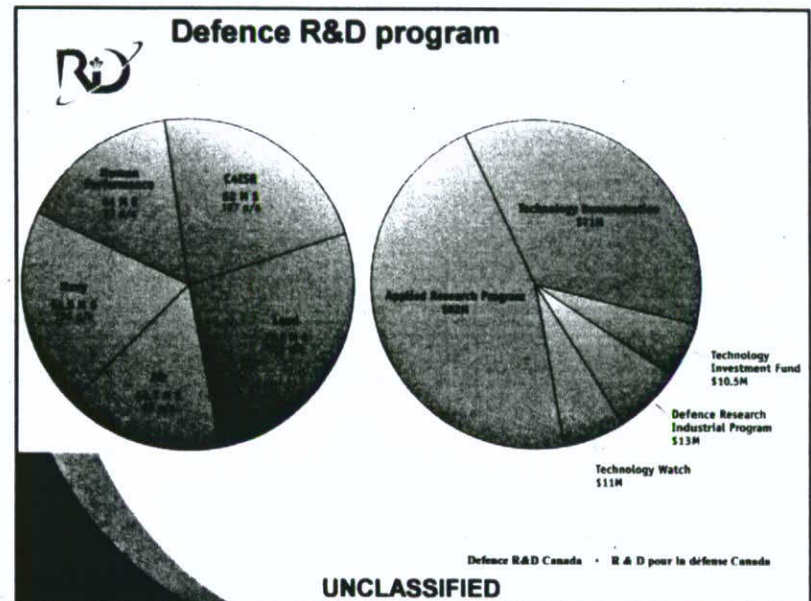
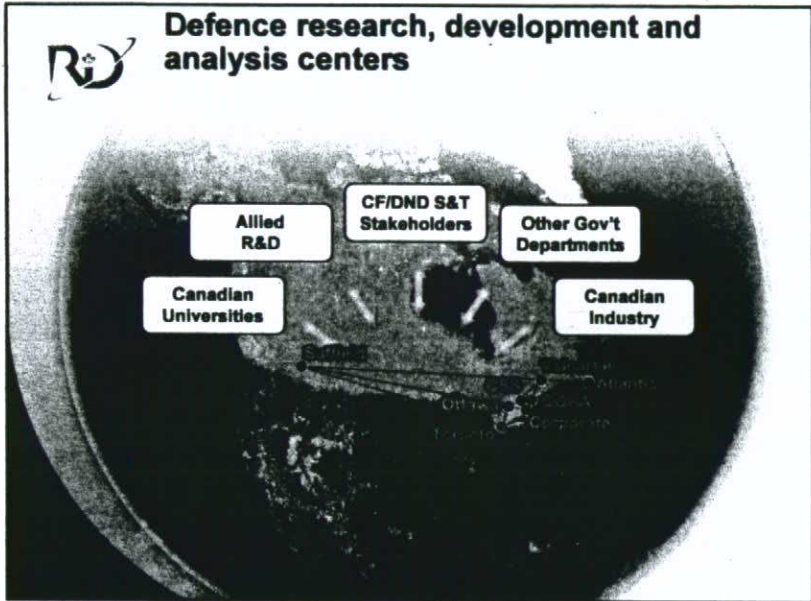
To ensure the Canadian Forces are technologically prepared and operationally relevant.

- Advise on Science & Technology
- Conduct defence research, development and analysis
- Assess technology trends, threats, and opportunities
- Engage industrial, academic and international partners in the transition of technology
- Conduct S&T projects for non-DND



Defence research, development and analysis centers

- DRDC Valcartier**
 - Command & Control
 - Intelligence & Information
 - Tactical Surveillance & Reconnaissance
 - Spectral and Geospatial Exploitation
 - Electro-optical Warfare
 - Energetic Materials
 - Weapons Effects
 - Precision Weapons
 - IDV
 - METC (ADM MAT)
- DRDC Ottawa**
 - Radiological Analysis & Defence
 - Network Information Operations
 - Electronic Warfare (Radar, Comm & Nav)
 - Future Forces Synthetic Environment
 - Radar Applications & Space Tech
 - Radar S
- DRDC Suffield**
 - CCMAT
 - CTT
 - Military Engineering
 - Autonomous Intelligent Systems
 - Chemical & Biological Defence
- DRDC Toronto**
 - Aerospace & Undersea Medical Science Centre
 - Human Effectiveness Experimentation Centre
 - Adversarial Intent
 - Collaborative Performance & Learning
 - Human Systems Integration
 - Individual Readiness
- COS S&T**
 - R&D Programs
 - Corporate Services
- DRDC Atlantic**
 - Underwater Sensing
 - Maritime Information and Combat Systems
 - Air Vehicles
 - Warship Performance
 - Emerging Materials
 - Dockyard Lab (Pacific)
- CORA**
 - Quantitative & Strategic Analysis
 - Operational Efficiency
 - Management Quality
 - S&T Intelligence



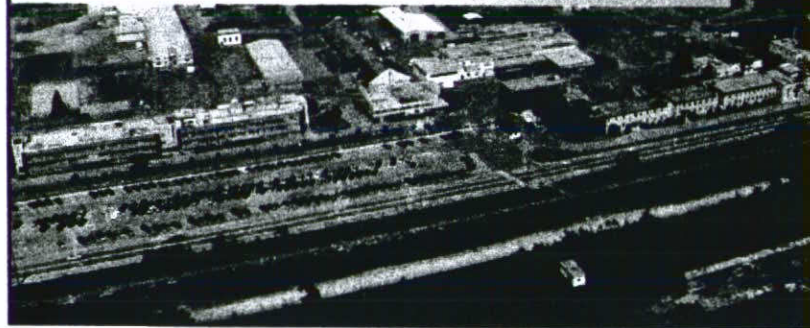
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Staff

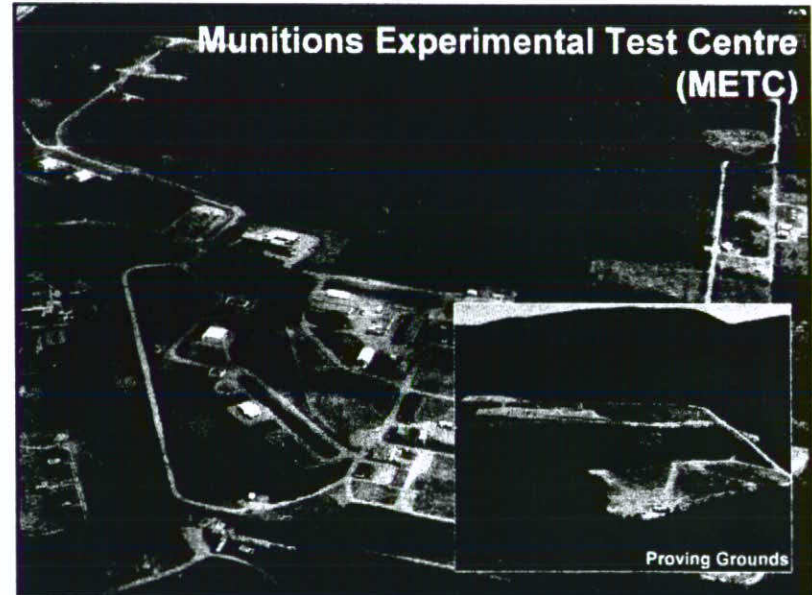
Civilians: 400

Canadian Forces: >20

Budget: >\$70M



Munitions Experimental Test Centre (METC)





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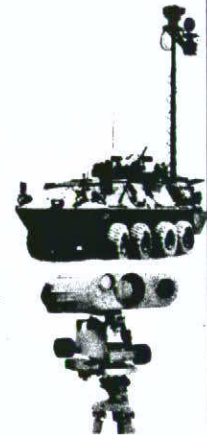
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Lasers in modern warfare I - sensing


- Rangefinding: time-of-flight calculation to determine target distance
- LIDAR: surface mapping for topography
- Active imaging: remote detection of hostile devices / chemical substances with optical signatures
- Detecting: warning the operator of laser designation




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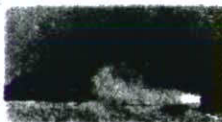
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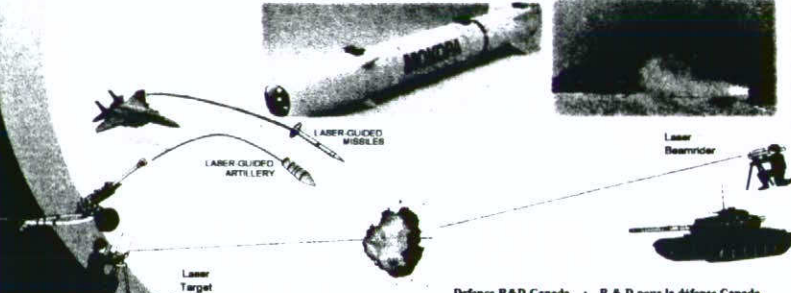
Lasers in modern warfare II - guiding



- Semi-active laser guiding: the weapon's front sensor direct it towards the spot.
- Laser beamriding: the weapon's rear sensors maintain it aligned with the beam.










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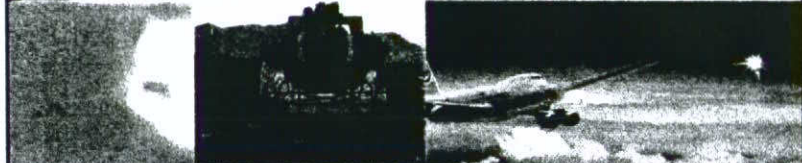
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Lasers in modern warfare III - neutralizing



- Multi-function laser
 - Dazzling, jamming & decoy
- High power lasers
 - Ballistic missiles: airborne laser demo 2009-10 (ABL)
 - Rockets: deployed (Northrop Grumman MTHEL)
 - UAVs: demonstrated (Boeing Avenger)
 - IEDs and UXOs: deployed (SPARTA Zeus)





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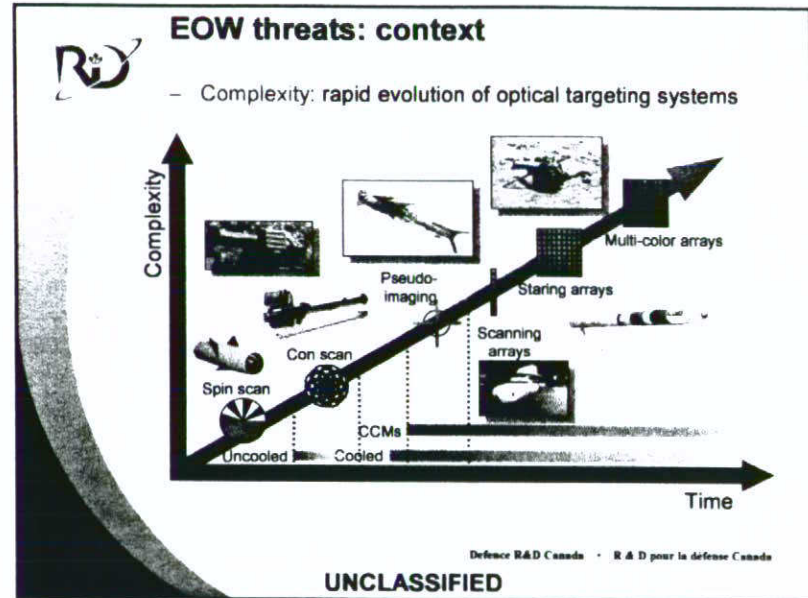
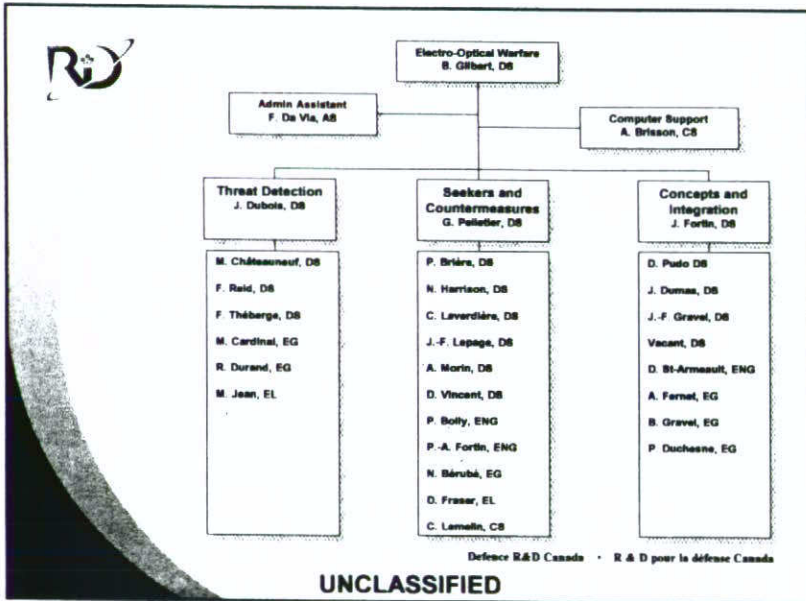


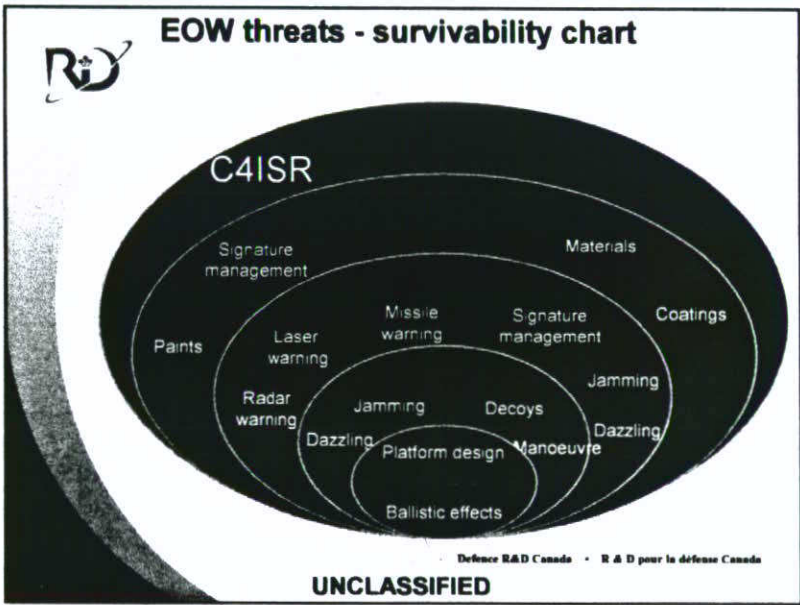
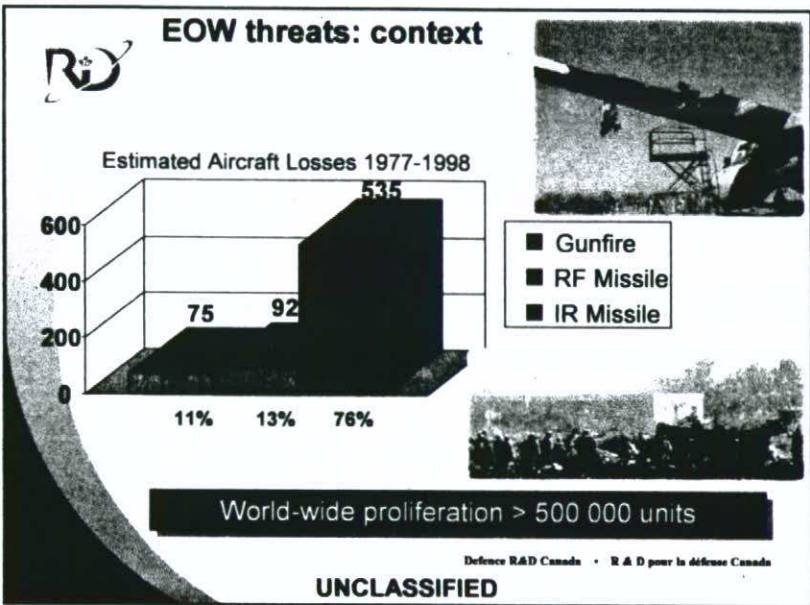
EO Warfare section mission

- Provide R&D services to the CF in the general area of electro-optical warfare, with the objective to improve the self-protection capabilities of military platforms in all operational conditions
 - Self-protection against laser and IR-guided weapons
 - Hardkill and softkill protection
 - Maritime, land and air platforms
 - IR signature management
 - Modelling and simulation of engagements
 - Interaction between self-defence systems

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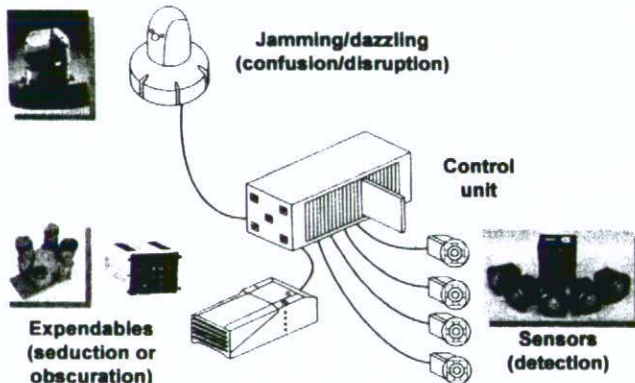






EOW threats- solution

- Detect: Identify type and location of threat
- Counteract: neutralizing/dazzling/jamming/obscuring



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Navy EOW – rationale

EO threats to maritime platforms

- Ships are large, slow targets with limited maneuverability
- Small EO weapons can precisely hit vital components
- Laser threats (passive): ManPADS-type systems incorporating imaging infrared seekers
- Laser threats (active): Laser designated weapons, laser beamriders
 - fast (LBRs fly up to Mach 4)
 - can be fired from short ranges (littoral)



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Navy – Laser Optical Countermeasures Against Threat Environment (LOCATES)

Objectives:

- Threat analysis to assess ship vulnerability to laser/optically assisted weapons
- Identify, develop and demonstrate a laser/optical surveillance and CM architecture.



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Navy – Laser Optical Countermeasures Against Threat Environment (LOCATES)

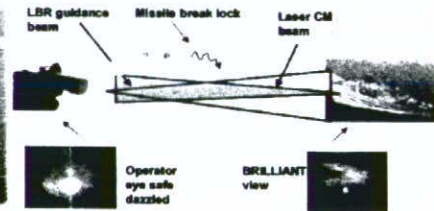
Technologies:

- Laser retro-reflection surveillance (GLARES)
- Ultra-sensitive laser detection, tracking and CM (BRILLIANT)
- Far off-axis laser detection system (LASSOS)

GLARES
(retro-reflections)



BRILLIANT
(against LBR)



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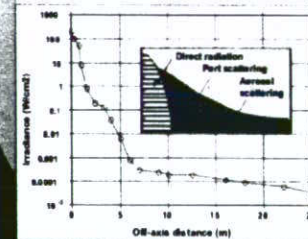


Navy – Laser Optical Countermeasures Against Threat Environment (LOCATES)

Capabilities:

- Detect, locate and defeat laser-assisted threat in harbor and littoral environment.
- Active weapon sight/optics detection & localization

LASSOS
(against LTD)



Laser Detector Array



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Army – signature management

Development of Mobile Camouflage Materials and Systems

NATO Project Imcavs AddCam Gen. I Kares Kares II



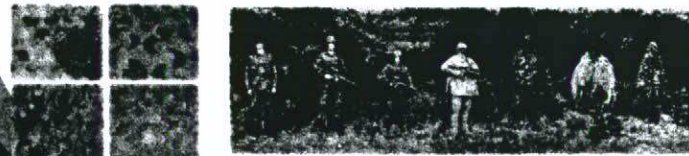
1998

2002

2004

2006

Personal signature reduction



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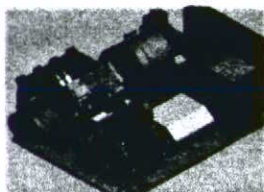
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Army – U-GLARES

U-GLARES (Gated LAser REtro-reflection Scanner for Urban ops)

- Eye safe surveillance system capable of detecting threats by retro-reflection in a range of 50 to 500 meters
- Detecting and geo-localize optical devices directed at U-GLARES



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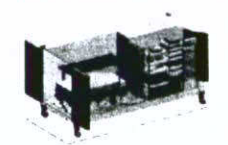
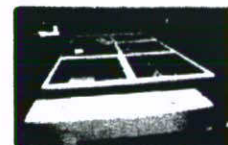
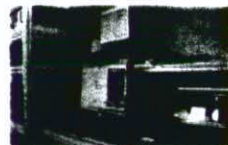
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Army

Terahertz & Terawatt (T&T) portable laboratory

- Ti:Sa laser + amplifier: <math><50\text{fs}</math>, 0.25 J, 5 TW, 10 Hz
- Mounted in portable container for mobility and environment control



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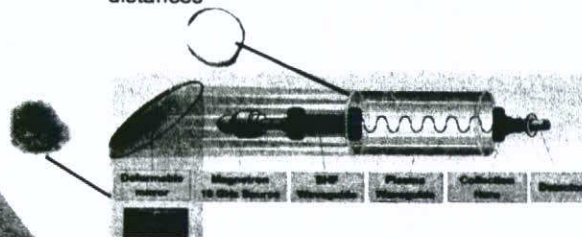
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Army – zaplight

ZAPLIGHT (Zone Active Protection Laser Ionization for Guidance of High-power Transients)

- To perturb or damage sensors, electronic circuits, IEDs, seekers, weapons
- By guiding energy (high voltage, microwave, ...) through ionized channels
- By generating white light or other wavelengths at distances



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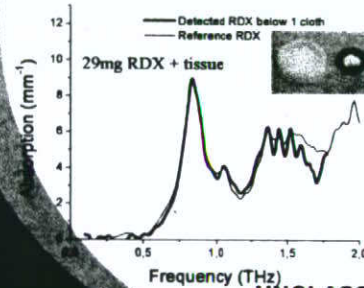
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Army – Chemical identification

Terahertz standoff spectroscopy for chemical identification project

- Use Femto laser pulses to generate THz waves
- Do pulsed THz standoff spectroscopy both in transmission and reflective modes
- Remote sensing and identification of concealed biological and explosive substances, through clothes or containers



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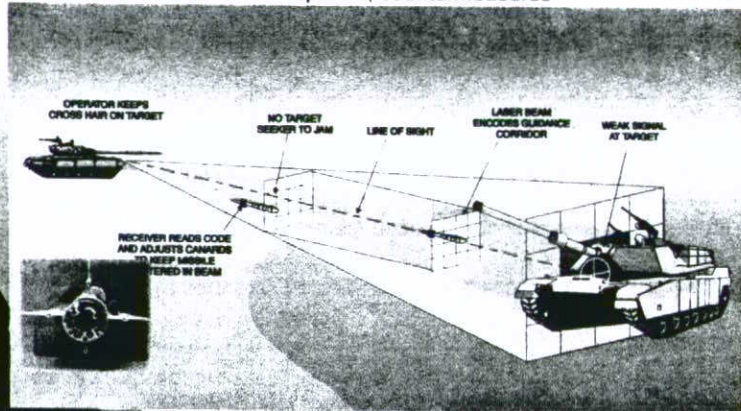
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Army – Laser off axis guidance



Typical beamriders

- Missile detects aft array to guide its trajectory
- Issue: missile plume, countermeasures



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Army – Laser off axis guidance



Typical beamriders

- Missile detects aft array to guide its trajectory

Off-axis guidance

- Missile detects scattered light from nearby beam and maintains a designated trajectory till the target



Laser sensor's field of view



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Air Force – signature management

Objective

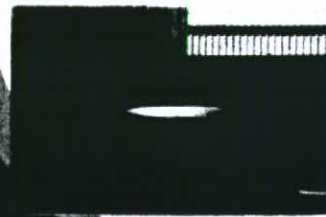
- To develop and validate experimental tools to model aircraft IR signature with the appropriate accuracy for IRCM development

The problem

- The understanding, evaluation and control of aircraft EO signature is critical to maximize survivability

Output

- A better representation of aircraft signatures
- A method to estimate the IR signature of new air platforms



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Air Force – engagement modeling

Complexity of modern systems prevents blind field trials
Multiplatform model for threat assessment



Environment

- Atmospheric transmittance
- Terrain
- Background



Soldier

- Geometry
- Dynamics
- Missile launch

Missile

- Geometry
- Aerodynamics
- Guidance
- Control
- Propulsion
- Dynamics
- Signature

Aircraft

- Geometry
- Dynamics
- Signature
- CMDS

Flare

- Geometry
- Dynamics
- Signature

- 10 Expendable dispensers
- 4 Imaging sensors
- EWR/CM
- 2 Turrets
- Imaging sensor
- Laser

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Air Force – engagement modeling

Physics-based modeling and simulation

- Define a combination of platforms, weapons, counter-measure and sensors suitable to provide the capability to deploy a air expedition
- Measures of performance and effectiveness
 - Probability of survival to an engagement
- Concepts
 - Helicopter
 - DEWS & weapons
- Strategies & tactics



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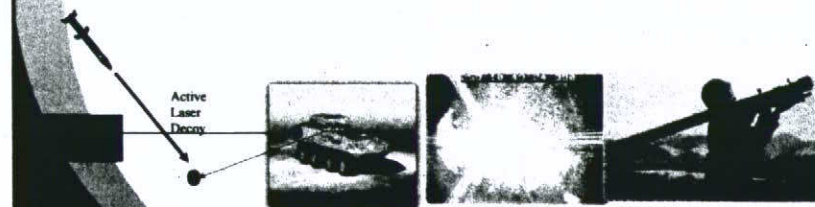
Air Force – targeting and countermeasures

Improving laser-assisted targeting

- To investigate the effect of countermeasures on laser targeting systems

Developing novel airborne countermeasures

- To investigate the effectiveness of various types of laser-based CM technologies (from CW to femtosecond lasers) for protecting military aircrafts



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Conclusion

- EO R&D challenges
 - Increasing proliferation of laser/IR-enhanced systems
 - Every platform and environment is affected
- EO R&D direction
 - Sensing (gases, explosives)
 - Detecting (observation optics, illuminators, target designators)
 - Concealing (camouflage, signature management)
 - Counteracting (decoy, dazzling, jamming)



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