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Air Force Scientific Advisory Board

Airborne Tactical Laser (ATL) Feasibility for Gunship Operations

2008 AF SAB Study

Presented at 34th Air Armament Symposium

8 October 2008

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Promise of Tactical Laser on a Gunship

Key attributes:

- Precision lethality
- Track and hit moving targets
- “Danger-close” of meters
- Minimal collateral damage
- Clandestine and invisible engagements
- Deep, onboard re-chargeable magazine*
- Variable effects – disrupt to destroy
- Reduce platform vulnerability
- Fewer crewmembers needed



* Electric lasers only, chemical lasers require chemical replenishment



Terms of Reference

-Charter-

- **Assess current state of airborne tactical laser technologies**
 - Consider both chemical and electric/solid state lasers
 - Identify platform integration issues (on C-130, C-27, C-17)
 - **Examine gunship operations and tactics, techniques and procedures**
 - Identify missions, operational requirements, logistics or sustainment issues which might limit laser weapons employment
 - **Assess tactical laser effectiveness against offensive and defensive gunship targets**
 - Identify potential effects
 - Assess vulnerability and countermeasures
 - **Recommend technology options for near, mid, and far-term**
-

Outline



- **Gunship mission**
- **System considerations**
- **Advanced Tactical Laser (ATL) ACTD**
- **Recommendations**

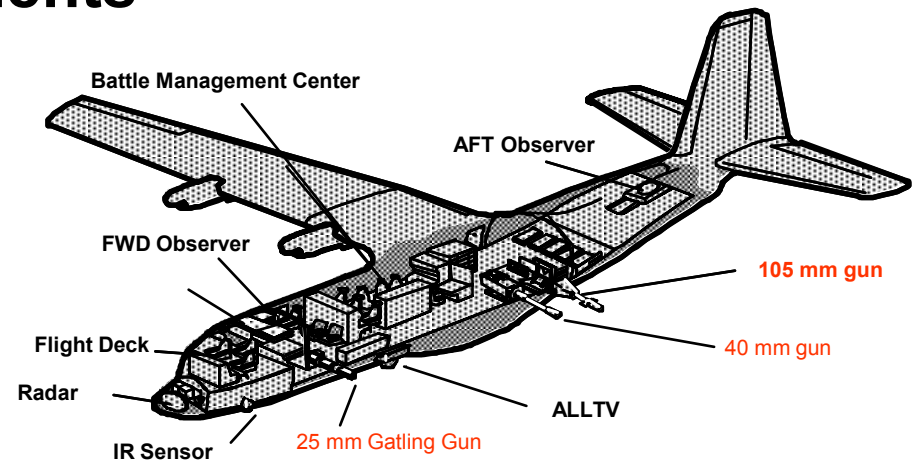
Current Gunship Mission

■ Tactics

- Night time and day time permissive ops due to platform vulnerability
- Close-in pylon turn

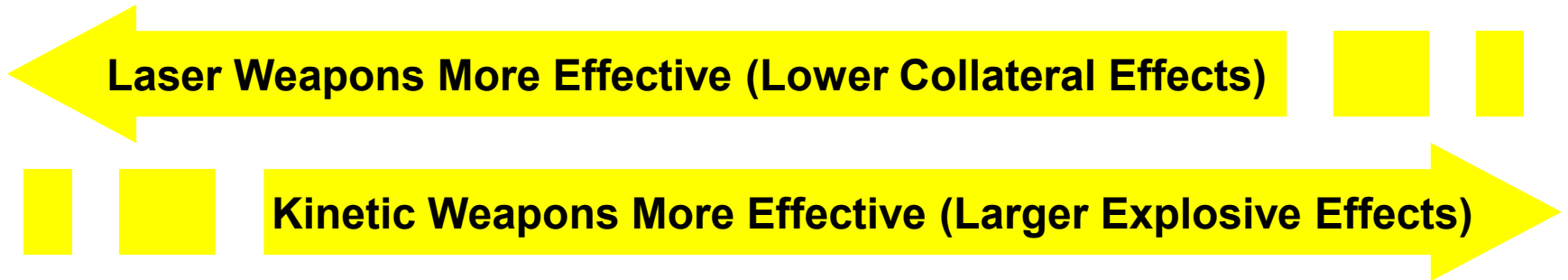
■ Principal Gunship requirements

- Situation awareness
- Lethality
- Persistence
- Survivability





Effectiveness and Tactical Target Lethality



Soft/Small/Fast

Moving/tactical

Hardened or Large Area

*Laser & kinetic weapons could play complementary roles
A Gunship with both laser and kinetic weapons can execute
more missions*

Outline



- Gunship mission
- **System considerations**
 - High energy laser choices
 - Beam control and atmospheric propagation
 - Aircraft integration & options
- Advanced Tactical Laser (ATL) ACTD
- Recommendations



System Considerations

Weapon lethality: ~2 kW/cm² at 7 km, dwell time 1/2 s to <10s

System Attribute

- Laser power
- Laser efficiency
- Thermal management
- Duty cycle
- Aperture
- Beam quality
- Jitter
- Atmospheric effects
- Standoff

**Weight and “wall plug”
power requirements**

□ Target prosecution rate

Spot size on target

□ Survivability



High Energy Lasers

<i>Attribute</i>	<i>COIL</i> (1.31 μ m)	<i>Bulk SSL</i> (1.06 μ m)	<i>Fiber SSL</i> (1.07 μ m)
Propagation Effects			
Ocular Hazard			
Rechargeable Magazine			
Technical Maturity			

Solid State Laser provides a technically maturing option with operationally relevant magazine depth, good beam propagation, and decreased danger close distances

Beam Control for Laser Gunship

Disturbance	Severity
Jitter (Platform motion)	Severe
Aero-optics Turbulence	Benign in forward region
Atmospheric Turbulence	Benign
Thermal Blooming*	Significant (COIL) Benign (SSL)



*Distortion caused by laser heating of the atmosphere (water vapor)

Principal challenges: Maintenance of aimpoint and rejection of platform-induced jitter
Payoff: Reduces laser power, and lower system weight



Trade Offs between Laser Power, Aperture and Jitter

Bigger Optics or More Laser Power?

Larger Laser, Smaller Aperture

- **Simpler beam director integration**
- **Reduced requirements on beam quality and jitter**
- **Stressing thermal/power integration**

Smaller Laser, Larger Aperture

- **Simpler laser integration**
- **More stringent requirements on beam quality and jitter**
- **Enhanced ISR capability**

- **Laser requirements can be considerably reduced by increasing aperture size and reducing platform jitter**
- **Same lethality is achievable with variety of power-aperture combinations with system implementation (e.g., weight) implications**
- **High fidelity system models are needed to guide laser weapon system development**



System Considerations

- **Weapon lethality: $\sim 2 \text{ kW/cm}^2$
dwell time 1/2s to $< 10\text{s}$**
- **Mission characteristics:**
 - 7 km slant range, 50 s continuous run time
 - 10% duty cycle

System Attribute	Nominal System Design
Laser Power	100 kW
Efficiency	14%
Thermal Management	615 kW Peak load input 31 MJ storage 310 kW dissipation
Duty Cycle	10%, 50s continuous run time
Beam Quality	2
Jitter	2 urad
Atmospheric Effects	Compensation not needed
Aperture	50 cm
Standoff	7 km slant range

Platform Integration

AC-130 and AC-27 gunships



- **Key challenge to A/C Integration:**
 - Available weight and volume
 - Electric power
 - Thermal management
 - Platform vibration isolation
- **Onboard capabilities vary across platforms**
 - Available A/C engine power
 - Use A/C fuel as thermal sink
 - Ram air cooling
(non Low-Observable)



Finding: Laser Augmented Gunship is Potentially Feasible for AC-130

Add laser system: SSL 100 kW, 50 cm aperture, 50 s run time, 10% duty cycle

Retain: 105 mm gun

Remove: 25 and 40 mm guns

Payload removed	Laser weapon system payload added
■ 25mm & 40mm guns, ammo, rack ■ Fewer crew members (2) ■ ALLTV ■ Rest station ■ Weight equivalent of drag count	■ Laser device ■ Beam Director/Optics ■ Electric Power System ■ Thermal Management System ■ C3 for laser



Finding: Laser Augmented Gunship is Potentially Feasible for AC-27

Add Laser system: SSL 75 kW, 50 cm aperture, 50 s run time, 10% duty cycle
Add other weaponry: precision guided munition (SOPGM) for complementary weaponry effects

Laser weapon system payload added

- **Laser device**
- **Beam Director/Optics**
- **Electric Power System**
- **Thermal Management System**
- **C3 for laser**
- **Mission Systems (no 30 mm gun)**
- **SOPGMs (50)**



Gunship Operational Options

- **AC-130 with an integrated laser weapon system and retaining 105mm gun**
 - Expanded mission with combined HEL and KE

- **Flight of two aircraft, for example:**
 - AC-27 with laser weapon, AC-130 with guns only
 - AC-27 operates as an adjunct to AC-130
 - Battle management resides in the AC-130
 - Two-way data link with streaming video
 - Two AC-27s (one with guns, one with HEL)

Outline



- Gunship mission
- System considerations
- **Advanced Tactical Laser (ATL) ACTD**
- Recommendations

Advanced Tactical Laser (ATL)

ACTD



Objective

**Demonstrate Military Utility
Assessment of Modular HEL
Weapon for Ultra-Precision Strike
Missions**

Key Attributes

- **Fills the entire C-130 Cargo Bay**
- **50 cm optics in a 130 cm retractable turret**
- **Sealed Exhaust COIL**



ATL ACTD Status

- Low power ground and flight tests completed
- High power laser installed on the aircraft and activated (on the ground)
- High power flight test not yet conducted
- ACTD to end in September 2008
 - Followed immediately by an EUE

As an integrated platform, could provide unique test and evaluation opportunity

Outline



- Gunship mission
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- **Recommendations**



Recommendation 1: Near Term Technology Development

Start with system analysis for combined laser and kinetic Gunship, ensure technology developments are consistent with system requirements

- **Initiate a comprehensive system engineering program to integrate laser weapon system on a Gunship**
- **Complete programs to mature SSL**
- **Aggressively pursue beam control system improvements including better jitter control and lightweighting**
- **Lightweight and improve electric power and thermal management technologies**



Recommendation 2: Mid and Far Term Technology Development

- **Incorporate future laser weapon system technologies for a Gunship (AC-130 or AC-27) into Air Force laser weapon roadmap:**
 - **Develop higher power, higher efficiency fiber SSL**
 - **Develop higher power, higher efficiency bulk SSL**
 - **Enhance beam control technologies (jitter below diffraction limit)**
 - **Reduce the total system weight**
- **Focus funds on developing a fieldable laser system**
 - **Build a laser weapon system which meets size, weight, power, laser efficiency, beam quality and jitter requirements**
 - **Design program based on goal of militarily useful system**

Fund platform modification only after laser system is well demonstrated



Recommendation 3: Extended User Evaluation (EUE) Using ATL

Purpose of EUE: Assess potential military utility

- **Develop a detailed, comprehensive EUE Plan**
- **Explore a range of scenarios using integrated airborne testbed**
 - Repeat and expand target sets beyond the 2 DRMs
 - Include diagnostics of beam at target
 - Validate detailed M&S for alternative scenarios
- **Restrict upgrades of the ACTD configuration to beam control**
 - Measure platform jitter impacts on system performance
 - Retain existing COIL as is for EUE
- **Emphasize potential user test and evaluation**
 - Develop CONOPS
 - Conduct ground tests to enhance current lethality database



Summary

- **Laser development for Gunship applications should focus on solid-state laser (SSL) solutions**
 - **SSL more promising for gunship operations**
 - **Less absorption in the lower atmosphere**
 - **Larger magazine**
 - **Less complex logistics requirements**
- **Suggested way ahead – Develop future gunship with combined SSL and kinetic capabilities**
 - **Demonstration of laser system as first step before platform modification**



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- Mr Mark Neice, HEL JTO



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