WORLDWIDE FORCE PROTECTION

Ballistic missiles in the hands of nations hostile to the U.S. pose a global threat to U.S. and allied forces. Coupled with the proliferation of nuclear, biological and chemical weapons technology, this threat creates a growing menace to friendly military forces and civilian assets worldwide.

To counter this threat, the Missile Defense Agency is developing the Ballistic Missile Defense System (BMDS), a joint, layered defense architecture designed to intercept and destroy enemy ballistic missiles.

The Airborne Laser (ABL) provides boost phase intercept for the BMDS and a first line of defense in the system’s layered architecture. ABL tracks and intercepts all classes of enemy ballistic missiles in their boost phase of flight and/or cues other layers in the BMDS.

TRANSFORMATIONAL WEAPONS SYSTEM

ABL is a megawatt-class laser weapon system carried on a 747-400F aircraft. It is designed to detect, track and destroy hostile ballistic missiles in the boost phase, while they are highly vulnerable and before warhead separation. Rapidly deployable anywhere on the globe, ABL represents a revolution in the way battles will be fought in the future. It offers a multi-role mission capability to the U.S. Air Force to gain and maintain superiority in the battlespace.

ABL provides a unique capability to kill multiple missiles, significantly thinning the number of threats to be handled by the midcourse and terminal defense layers of the BMDS. This laser weapon system offers a powerful deterrent to the use of weapons of mass destruction because early intercept means any missile debris would likely fall on enemy territory. In addition, ABL provides launch and impact point predictions that support both defensive systems and attack operations. ABL intercepts threat missiles when they are most vulnerable and before their countermeasures are deployed.

MAJOR ACCOMPLISHMENTS

Basic aircraft modification complete
- Aircraft delivered to Air Force Flight Test Center
- First flight July 18, 2002
- Initial airworthiness flight testing completed
- Completed BC/FC airworthiness
- Installed BC/FC with return to flight on December 3, 2004
- Completed airworthiness tests and validated air data system March 2005
- Preparing for laser installation

BENEFITS OF ABL SPEED-OF-LIGHT LETHALITY

- Rapid global mobility deploys to world hot-spots within 24 hours
- Autonomous sensor/shooter weapon system for multi-role missions
- Speed-of-light lethality destroys boosting enemy missiles when they are most vulnerable
- Provides entire BMDS with track information

MULTI-ROLE GROWTH CAPABILITY

- Ballistic missile defense
- High-value asset protection
- Imaging surveillance
- Command and control
- Forward-based surveillance
- Laser communications

ABL PROGRAM OBJECTIVES

- Capture key technical knowledge points and risk reduction events
- Demonstrate feasibility of integrated directed-energy weapon for boost-phase missile defense
- Demonstrate BMDS interoperability and Emergency Operational Capability
- Incrementally deploy system capability
- Improve the system’s capability, maintainability and supportability
- Integrate new technologies to optimize boost-phase defense element with BMDS
**Airborne Laser Key Features**

**Beam Control System**
Lockheed Martin
- Target acquisition and tracking
- Fire-control engagement sequencing and aim point selection
- Shapes and adjusts power and intensity of High Energy Laser (HEL) beam
- Provides stable line-of-sight control to target
- Calibration and diagnostics for autonomous real-time operations and post-mission analysis

**Active Ranging System**
Boeing
- Modified LANTIRN with high-power CO2 laser
- Acquires target from IRST sensor cue, tracks target and points CO2 laser for ranging
- Helps determine missile launch point and impact point

**Battle Management**
Boeing
- Human-machine interface
- Surveillance and tracking
- Launch and impact point predictions
- Theater interoperability and communications
- Target detection, identification, prioritization and nomination
- Modular console construction
- Extensive use of commercial hardware
- Standardized and secure data links (Link 16/T125) to theater assets
- Open systems-based software architecture
- Kill assessment

**Nose-Mounted Turret**
Lockheed Martin
- 1.5 meter telescope in turret focuses beam on missile and collects return image and signals
- Extensive wind-tunnel tests by Boeing validate the design
- Composite construction for roll shell
- Window stows to protect against birds and bad weather

**Battle Management System** integrated on aircraft and tested in flight
- Infrared sensors and command, control and communication hardware and software successfully integrated
- Demonstrated successful detection and tracking of a ballistic missile
- Initial Link 16 capability successfully integrated into software
- Initial predictive avoidance capability demonstrated in preparation for certification

**Beam Control integration and flight test successes**
- All flight hardware delivered—turret, beam control system and optical bench
- Beam control system demonstrated in flight
- Rotated turret
- Unstowed window
- Aligned and stabilized system end-to-end
- Passively acquired target
**Illuminator Optical Bench**
*Lockheed Martin*
- State-of-the-art, diode-pumped solid-state lasers
- Beam shaping and transfer, and alignment optics
- Lightweight composite bench and spaceframe
- Modular design as line replaceable unit (LRU) for ease of maintenance

**Advanced Resonator Alignment System**
*Northrop Grumman*
- "Benchless" laser resonator supports distributed optics
- Active bench alignment system isolates optics from disturbances
- Diagnostics suite measures high energy laser (HEL) performance
- Fast steering mirrors provide stable handoff to beam control system

**Fuel Supply**
*Northrop Grumman*
- Stores fluids and pressurants for high-power laser operations, e.g., hydrogen peroxide, ammonia and helium
- Uses composite overlap construction for weight and safety features high life cycle, vibration resistance and impact tolerance

**High Energy Laser**
*Northrop Grumman*
- Chemical Oxygen Iodine Laser (COIL) technology
- World record for chemical efficiency established
- Advanced materials—plastics, composites, titanium—used to reduce weight
- Modular design allows for graceful degradation
- Designed for aircraft safety and field maintainability

**High Energy Laser progress**
- 100% installation of laser hardware and plumbing for ground tests
- First light of six laser modules, November 2004
- Laser ground testing for lethal power, duration and altitude
- Initiated activities for laser disassembly and refurbishment to support installation on YAL-1

**System Integration Lab facility complete at Edwards Air Force Base, California**
- Ground Pressure Recovery Assembly to simulate high-altitude operations
- Chemical mixing facility certified for test operations
- Combined government and industry test team operating megawatt-class laser test site
MISSION EXECUTION

DETECTION. With the aircraft flying in friendly and protected airspace, ABL’s Battle Management system uses infrared sensors to scan the horizon for hot missile exhaust plumes. Sensors can operate autonomously or can be cued by other BMDS sensor assets.

ACQUISITION. Once a boosting missile is located, ABL’s three low-power laser systems track and characterize the missile. The Active Ranging System atop the aircraft measures the distance to the target. The Track Illuminator Laser (TILL) then acquires data on the missile’s speed and elevation to support a BMC4I estimation of probable point of impact. Finally, the Beacon Illuminator Laser (BILL) measures atmospheric distortion to enable the Beam Control/Fire Control optics to make compensating corrections in the High Energy Laser.

ENGAGEMENT. With the target identified and an aimpoint determined, the High Energy Laser – the COIL – is activated and precisely aimed through the aircraft’s nose turret. Adaptive optics in the Beam Control/Fire Control system continuously compensate for atmospheric distortions and focus the high energy beam on the missile body, causing it to structurally fail.
The Missile Defense Agency, U.S. Air Force and industry teammates Boeing, Lockheed Martin and Northrop Grumman have combined their significant technical strengths, skills and experience to demonstrate the feasibility of directed-energy weapons for boost-phase intercept. Together we offer unique capabilities and the long-term commitment needed to develop the Airborne Laser for ballistic missile defense.

**Boeing**

Boeing, which has integrated the nation’s most critical airborne systems into a wide range of aircraft, provides the modified 747-400F aircraft that is the platform for ABL, and the Battle Management and ground support systems. Boeing is the industry lead and systems integrator.

**Lockheed Martin**

Lockheed Martin brings 35 years’ experience developing precision acquisition, tracking and pointing systems as well as proven adaptive optics beam control technology. Lockheed Martin supplies the Beam Control/Fire Control system for ABL.

**Northrop Grumman**

Northrop Grumman, a leader in laser technology since 1961, has built the world’s only megawatt-class lasers. Northrop Grumman is responsible for providing the High Energy Laser (HEL), based on chemical oxygen iodine laser (COIL) technology, that is the lethal element of the ABL weapon system.