

Development of the NLOS-LS PAM Warhead

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GENERAL DYNAMICS
Ordnance and Tactical Systems

Raytheon

NLOS-PAM Team

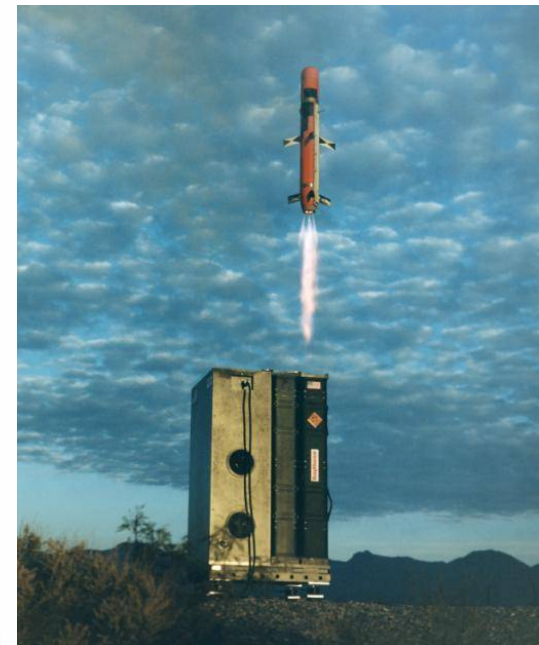
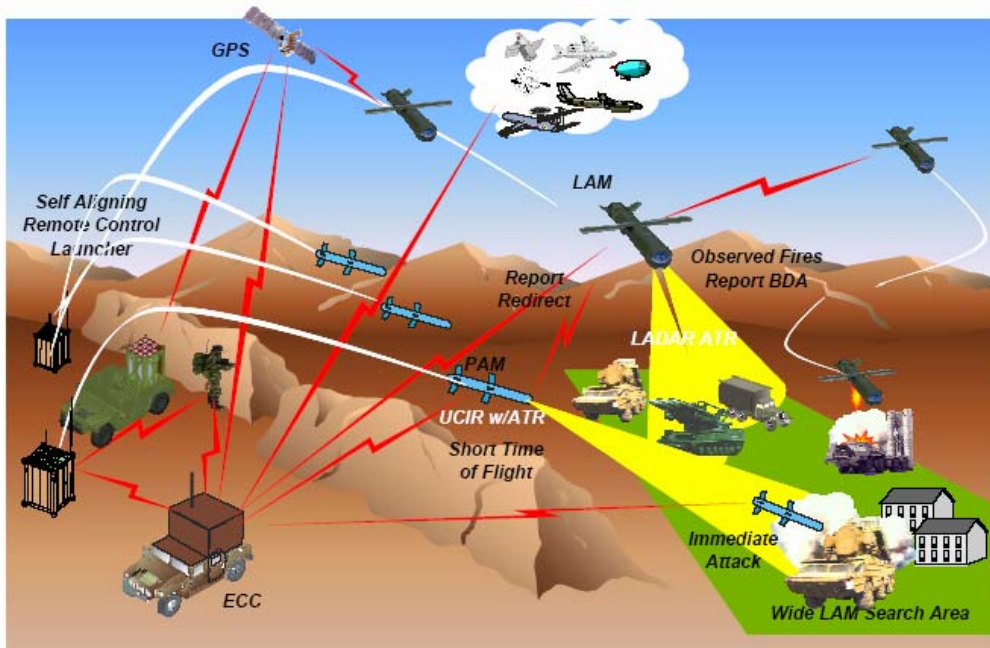


- Prime Contractor: NetFires LLC
 - Raytheon Missile Systems
 - Lockheed Martin Missiles & Fire Control



NLOS-PAM Overview

- Low cost, direct attack missile
- Provides precision fire support for the Brigade Combat Team and for USN Littoral Combat Ship





PAM System Description

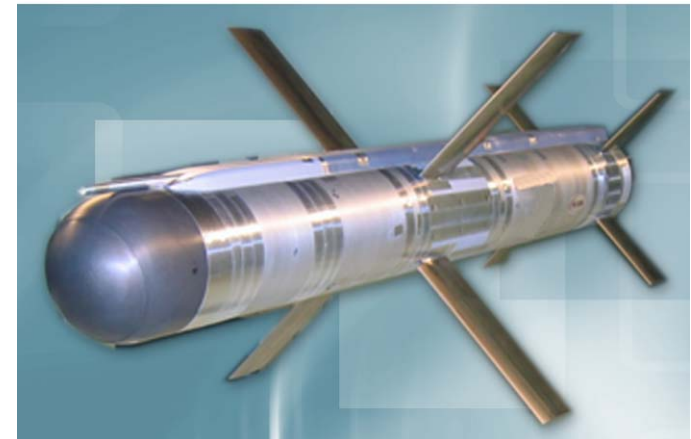
- Large multi-mode warhead
- 7-inch diameter 120 lb class
- Range 0-40 kilometers
- Effective against moving and stationary targets
- In-flight updates, retargeting and image capabilities
- Target sets
 - Light armor
 - Heavy armor
 - Bunkers
 - Fortifications



PAM Warhead Effectiveness

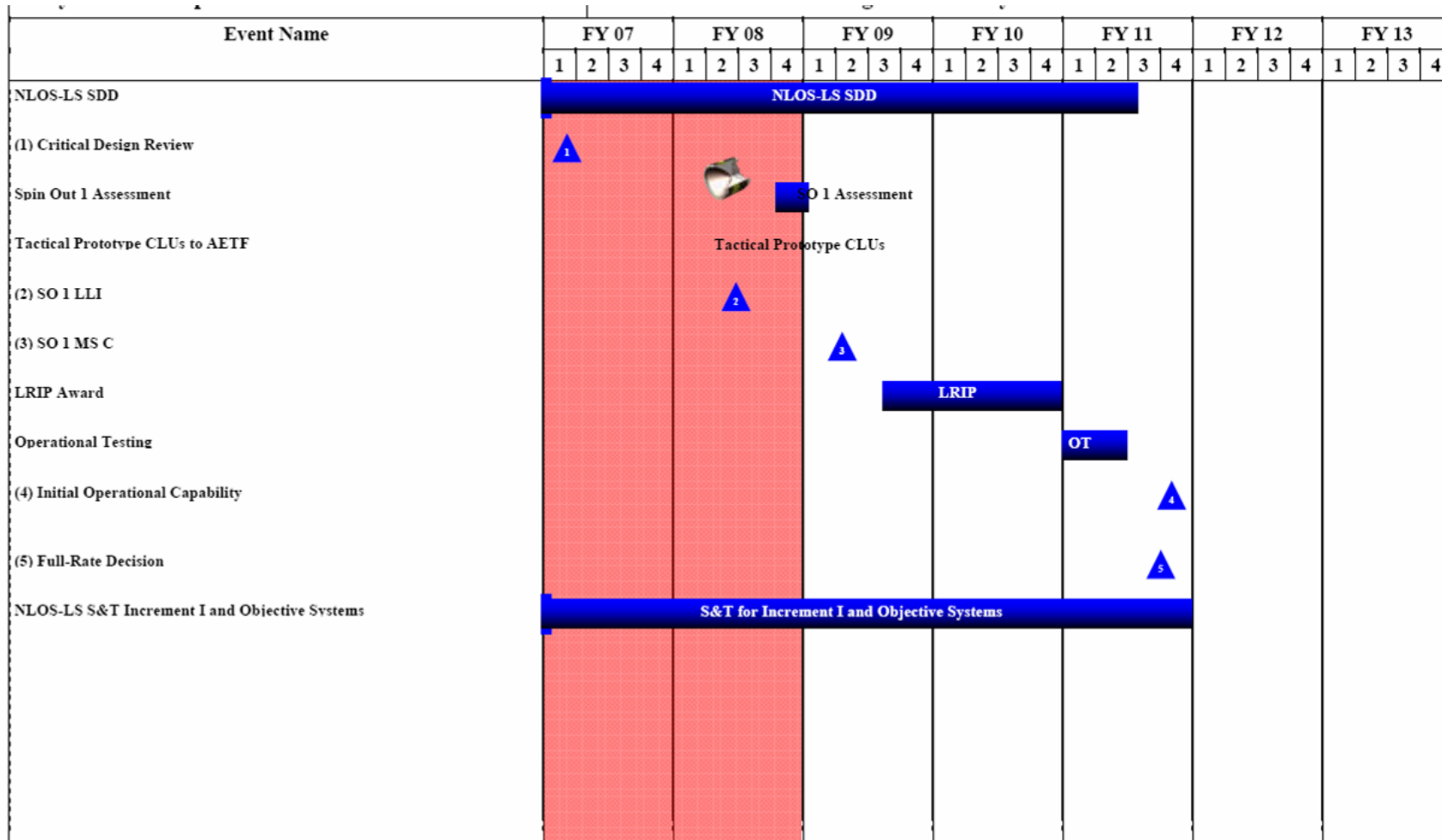


PAM Seeker Image of Land and Sea Targets





Program Schedule



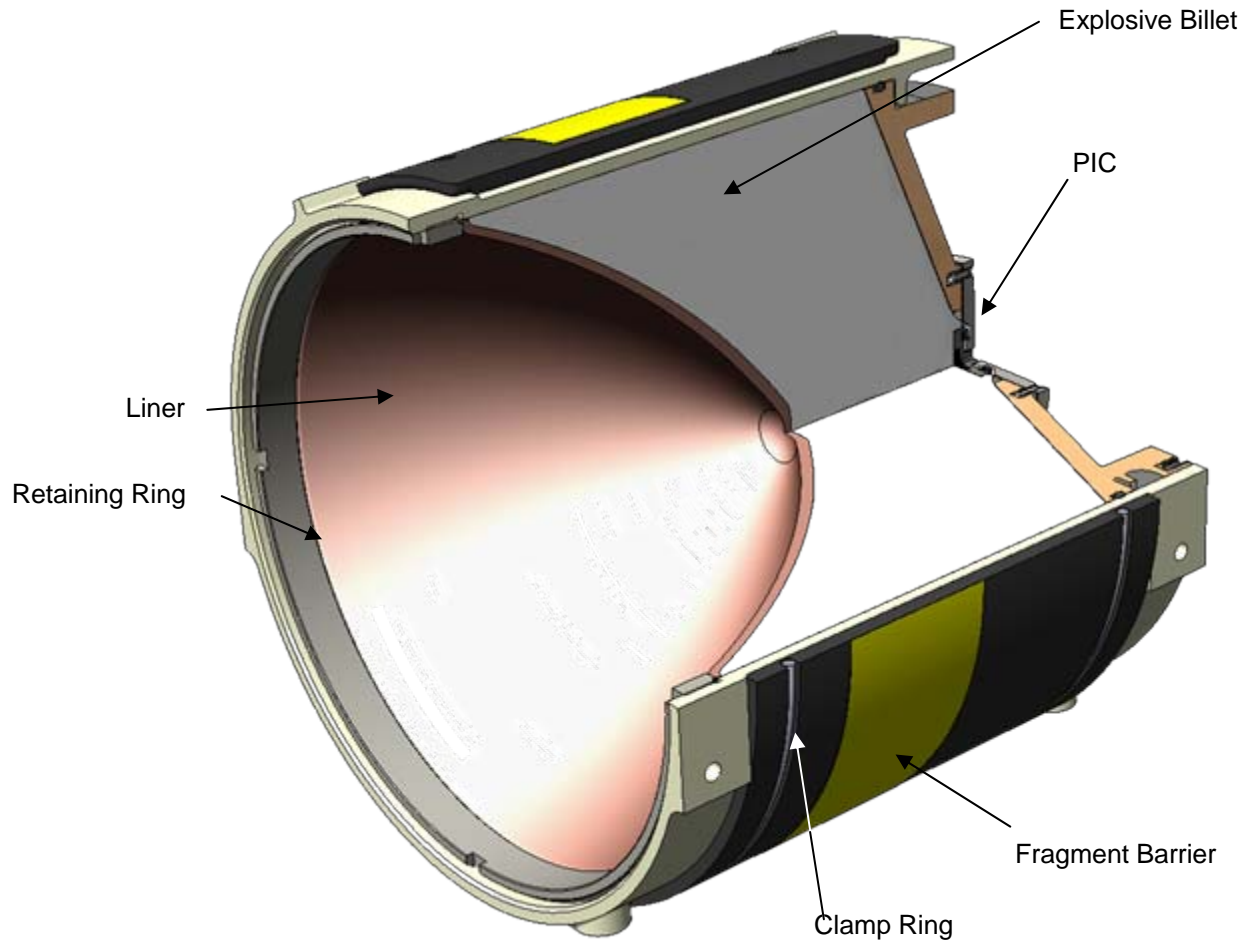
Multimode Warhead Challenges



- Short Stand-Off
- High Penetration Performance
- Strict IM requirements
- Cost as a Key Performance Characteristic
- Small Envelope
- Evolving Requirements



Warhead Overview





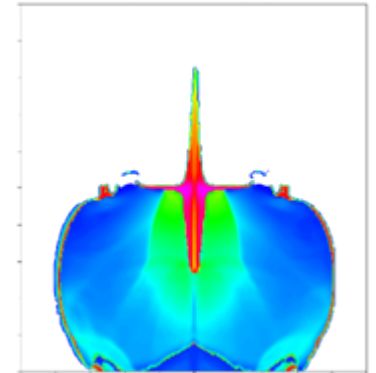
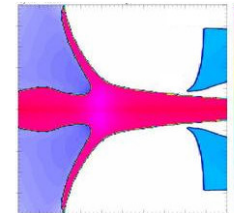
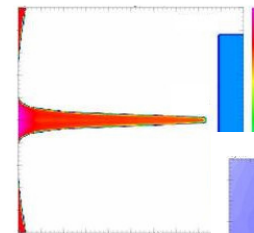
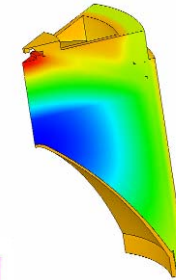
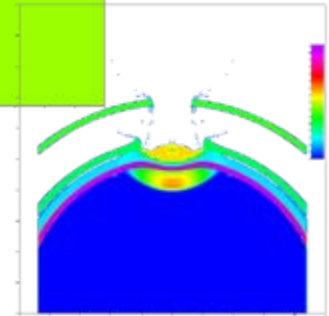
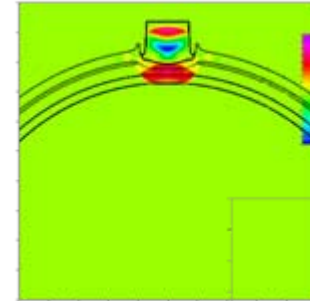
Warhead Development

- Competitive Risk Reduction Effort
 - Trade Studies
 - Explosive Material (Penetration Performance vs. IM Performance)
 - Casing Design (Materials to reduce sensitivity to Fragment Impact)
 - Liner Material Study (Penetration Performance vs. Cost)
 - Analysis
 - Penetration Performance (Hydrocode)
 - Seeker Keep Out Zone
 - Testing
 - Jet Characterization
 - RHA and Armor Targets (Penetration Performance)
 - Soft Targets (Arena and Bunker Testing)
 - Insensitive Munitions Testing (Slow Cook-Off and Fragment Impact)
- Followed by the Detail Design Phase



Modeling & Simulation

- Fragment Barrier Analysis
 - Understanding the Physics
 - Study the effects of different Materials
 - Study the effects of different configurations
- Slow Cook-Off Performance Analysis
 - Design Features to Allow Venting
 - Thermal Analysis
- Penetration Performance
 - 2D Hydrocode
 - Optimize Design
- Jet Characteristics
 - 3D Hydrocode
 - Ensure Straightness of Jet





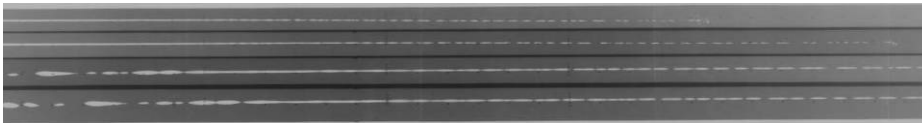
PAM Warhead Performance

Key Characteristic	Performance
Range target penetration depth	
Range target penetration diameter	
RHA penetration	
Mass	
Design to cost	



Performance Testing

- Tested 5 Different Design Variations
- Conducted over 100 Explosive Tests
 - Arena Testing
 - Jet Characterization
 - RHA Penetration
 - ERA Target Penetration
 - Environmental Testing
 - Behind Armor Debris Testing
 - Reliability (Vari-Comp)



IM Testing



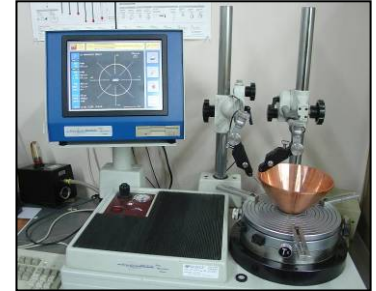
Threat	Test Results
Fast Cook-off	Type V
Slow Cook-off	Type V
Bullet Impact	Type V
Fragment Impact	Type V
Sympathetic Detonation	Type V*
Shaped Charge Jet	Type I*

*=Expected



Production Readiness

- Lean Design Effort
 - Use Low Cost Materials
 - Reduction of the number of Parts
 - Incorporation of Molded Components
 - Detail tolerance stack up analysis to optimize tolerances
 - Work with each component Vendors on reducing Cost Drivers
 - Streamline Assembly Process
- Early Development of Acceptance Testing
 - Perform Lot Acceptance Tests (LAT) to Characterize Variation
- Control of Critical Characteristics
 - Characteristics that mostly control performance variation
- Pilot Production Line incorporated on Qualification Build





Design Challenges

- Striking a Balance between Low Cost and High Performance
- Integrating Production Processes early on
- Mitigating Fragment Impact and Slow Cook-Off Hazards
- Maintain Performance with Environmental Factors
- Incorporating Environmentally Compliant Processes and Products



Acknowledgements

- Raytheon Missile Systems
 - Bill Zarr