Development of the NLOS-LS PAM Warhead

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GENERAL DYNAMICS
Ordnance and Tactical Systems

Raytheon

PO Box 11337
Tucson, AZ 85724-1337

NLOS-PAM Team

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

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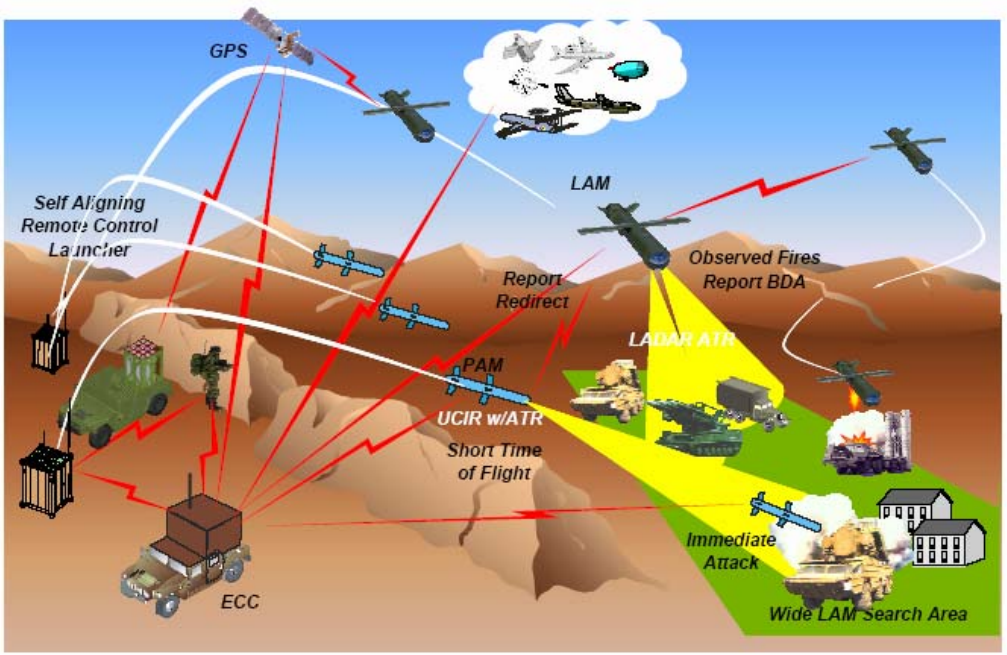
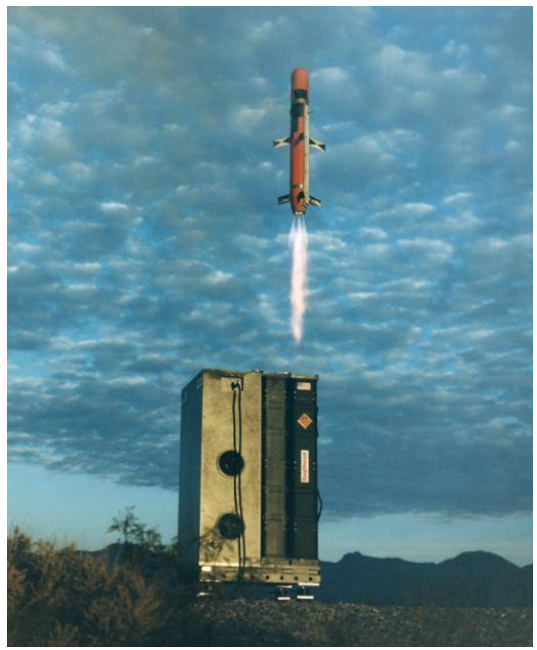
NLOS-PAM Overview

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



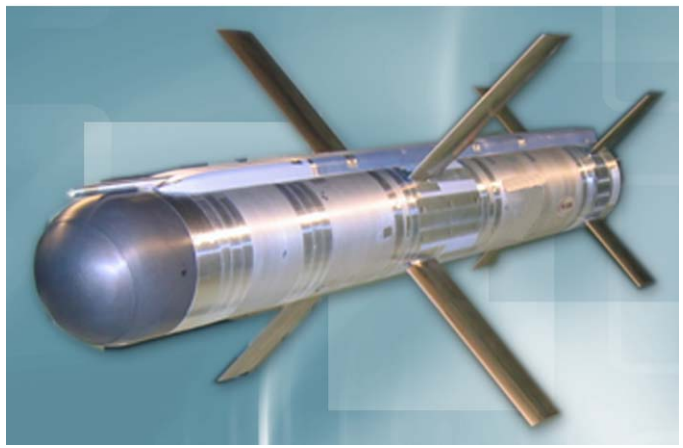


PAM System Description

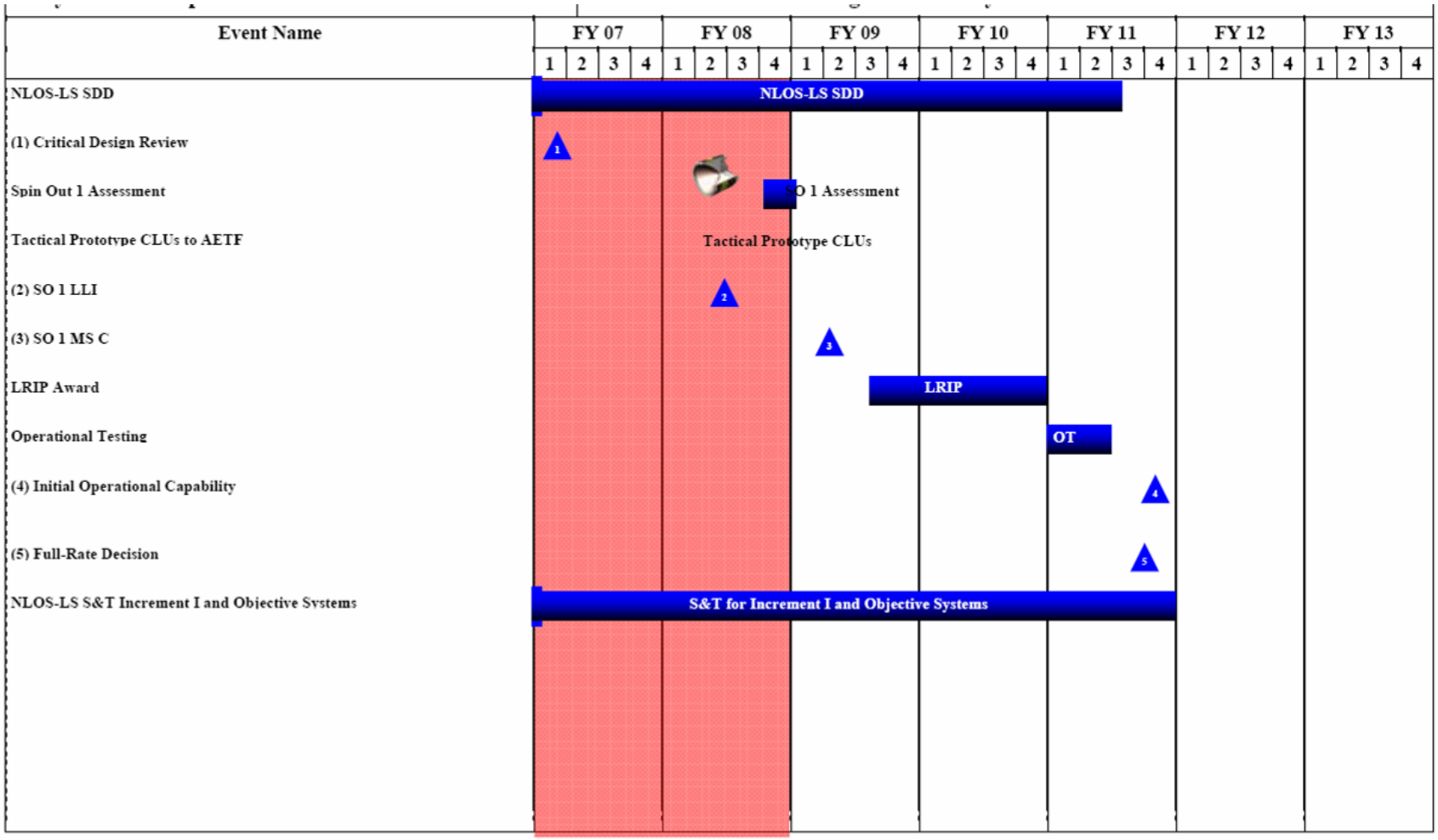
- Large multi-mode warhead
- 7-inch diameter 120 lb class
- Range 0-40 kilometers
- Effective against moving and stationary targets
- In-flight updates, retargeting and image capabilities
- Target sets
  - ↗ Light armor
  - ↗ Heavy armor
  - ↗ Bunkers
  - ↗ Fortifications

PAM Warhead Effectiveness

PAM Seeker Image of Land and Sea Targets



Program Schedule



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Multimode Warhead Challenges

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

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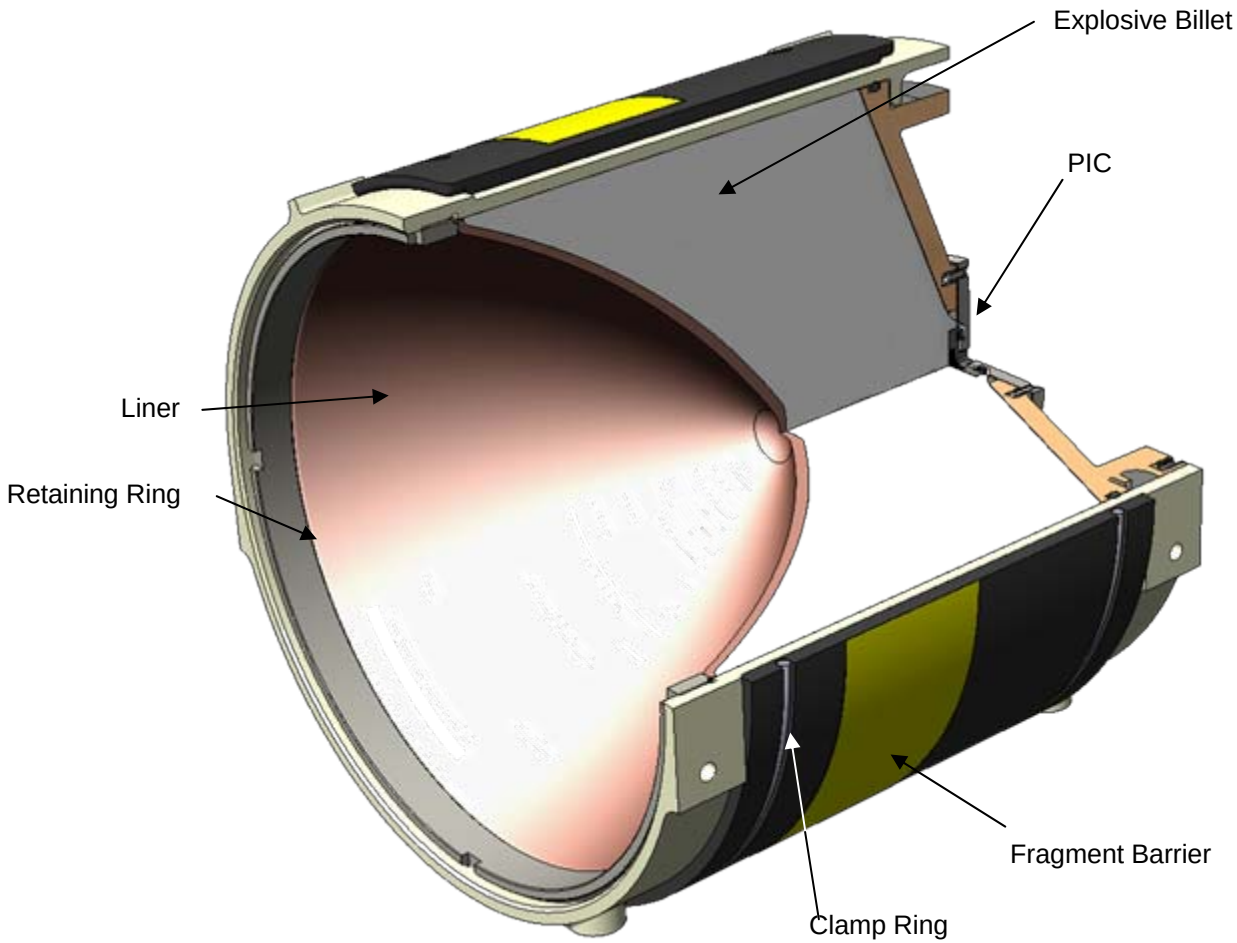
Warhead Overview



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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

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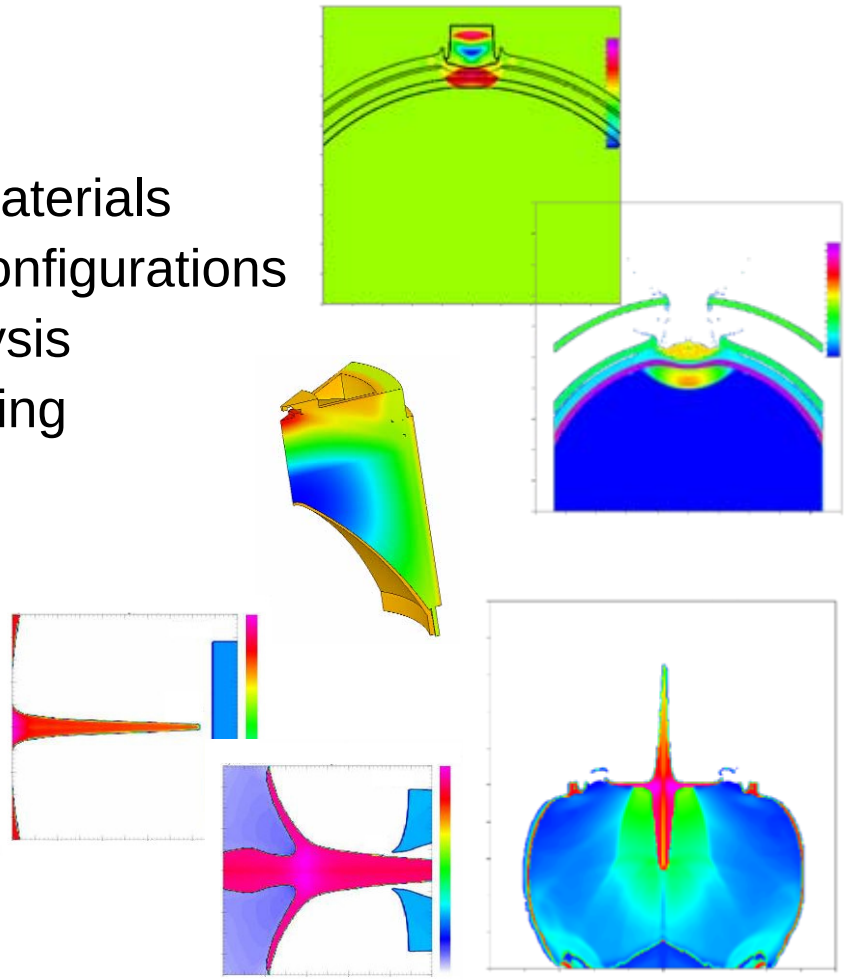
Modeling & Simulation

- 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



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PAM Warhead Performance

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

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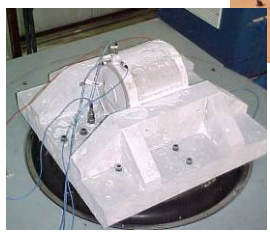
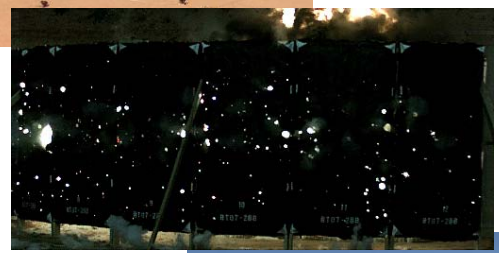
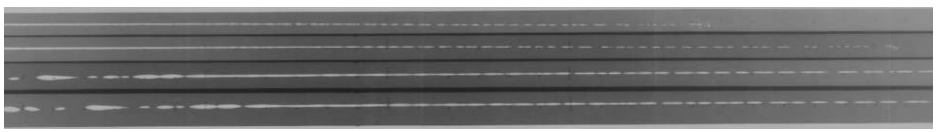
Performance Testing

- 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)





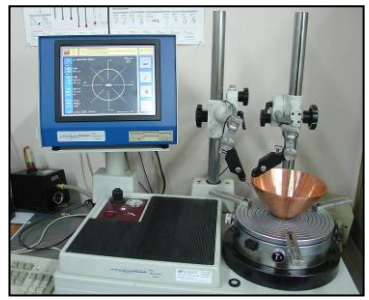


IM Testing

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

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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

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Acknowledgements

- Raytheon Missile Systems
  - ↗ Bill Zarr

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