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46th Annual Gun & Missile Systems Conference & Exhibition

Development of the Interceptor System for the Extended Area Protection & Survivability (EAPS) Gun System

POC: Mitch Danielson, ATK EAPS Technical Director

EAPS Tactical Concept “Demo Configuration”

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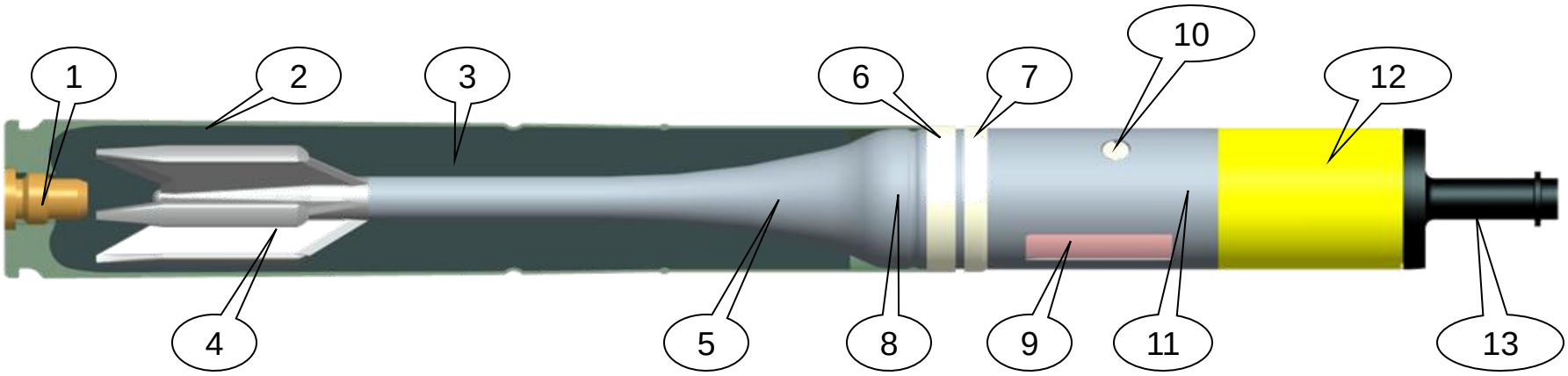

1. Primer
   M115 percussion primer
   Black powder flashtube
2. 328mm steel cartridge case
3. Nitrochemie ECL propellant
4. Aluminum 6 vane fin
5. 7068-T6 aluminum aft-body
6. Nylon obturator
7. Nylon rotating band
8. Set-back initiated battery
9. Electronics package
   TA transceiver
   ATK fuze electronics
10. Course correction divert thruster
11. ATK safe and arm device
12. Warhead
    4340 Steel body
    140g PAX-2A HE charge
    PBXN-5 booster
    Tantalum-tungsten 12 MEFP liner
13. Aluminum spiked nose

Application of Technology and Scientific/Engineering Principles

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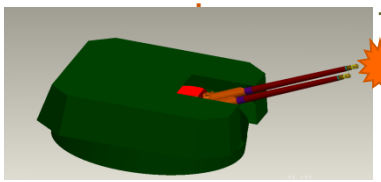
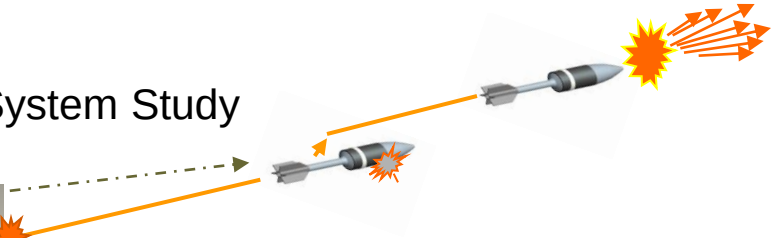
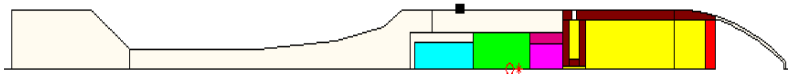
50mm System Study



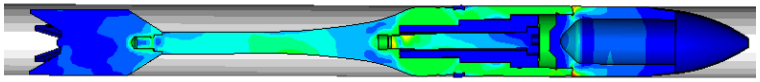


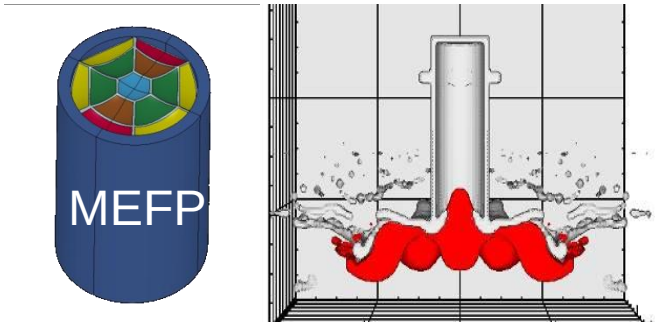
Projectile Configuration Study



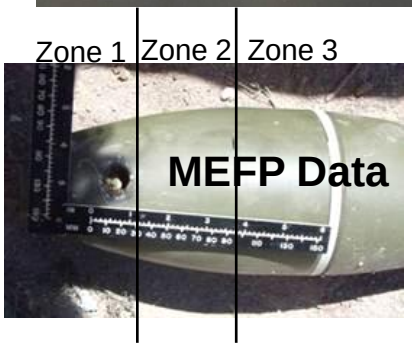
M&S Design Loop

Detailed Modeling & Analysis





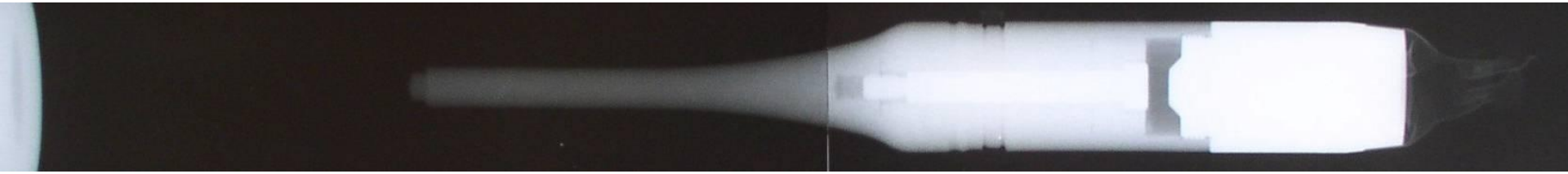
Test Data

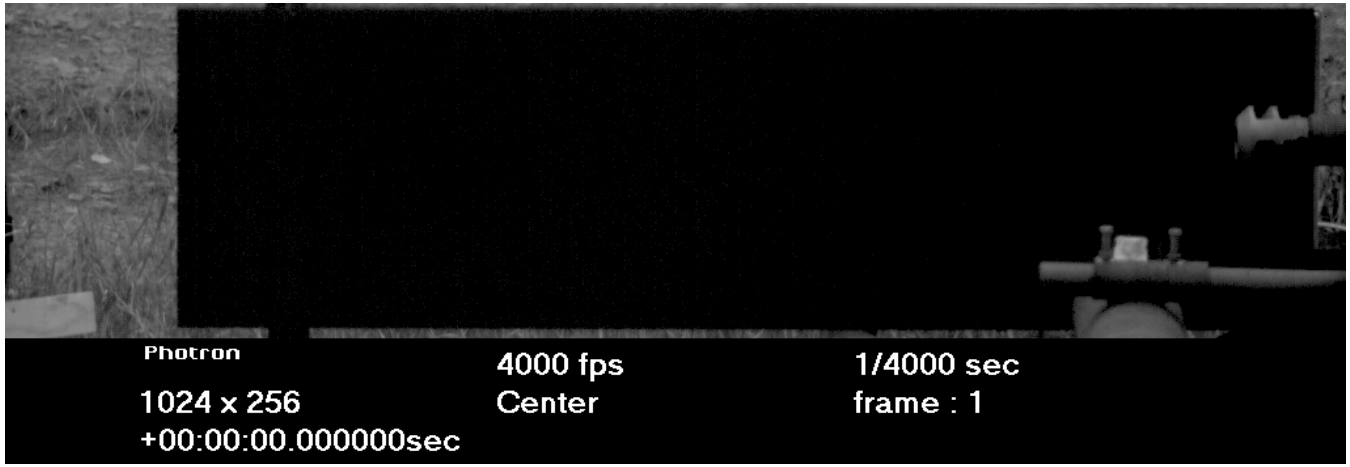


Projectile Design – Lessons Learned

- **Initial Ballistic Simulator Testing (100A)**
  - Four resulted in fin separation and windscreen damage (Typical example of X-ray shown, BS-001)
  - All showed evidence of obturation blow-by.
    - » Down-bore video shows light leakage early on
    - » Recovered band shows soot on exterior

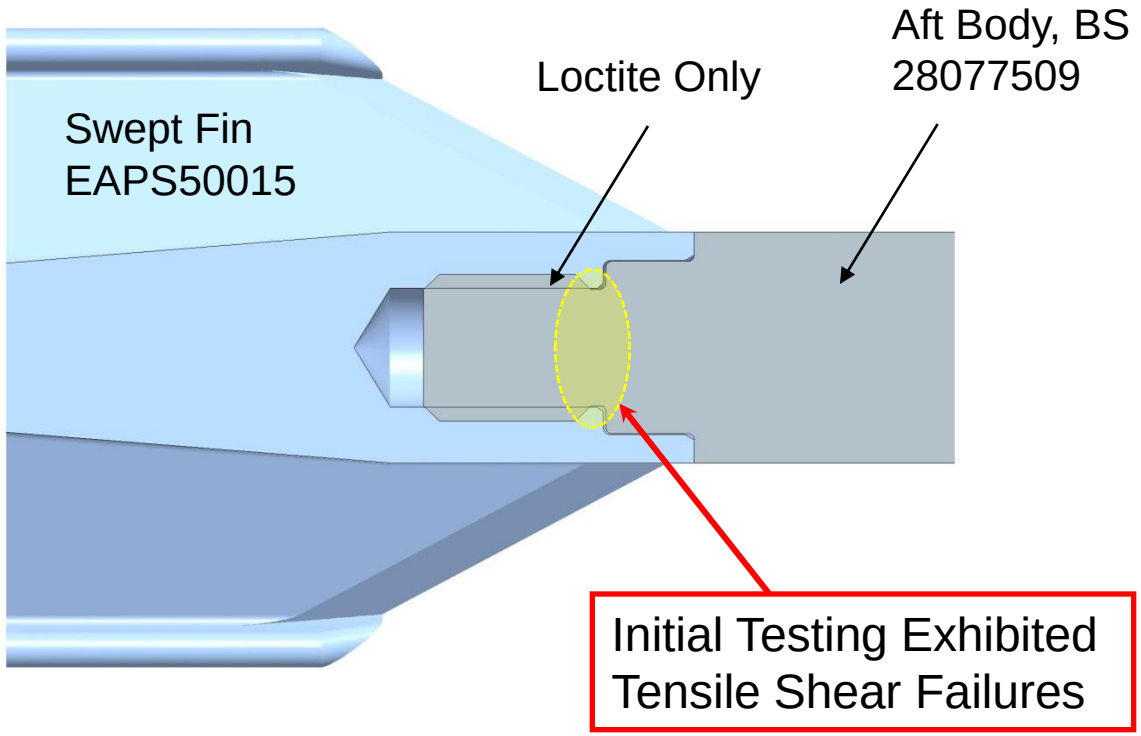
Early Test Iterations Identified Design Challenges





t4 sideview 1.avi

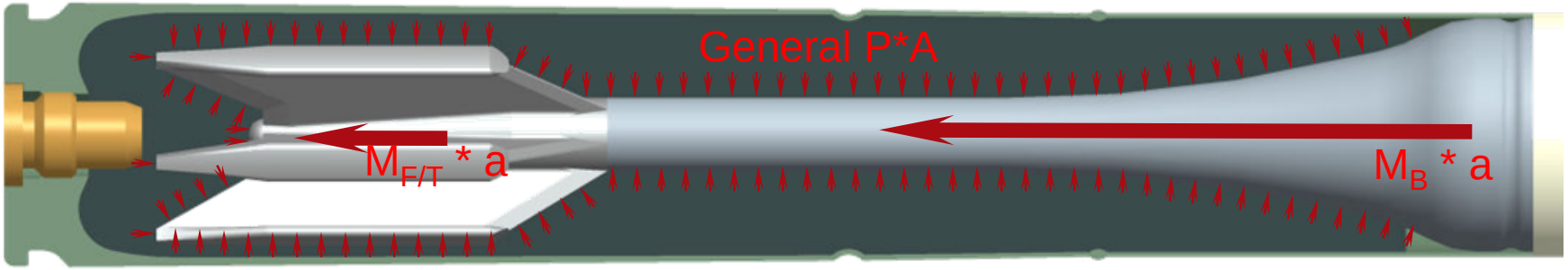
Baseline Fin Boom Interface (section)



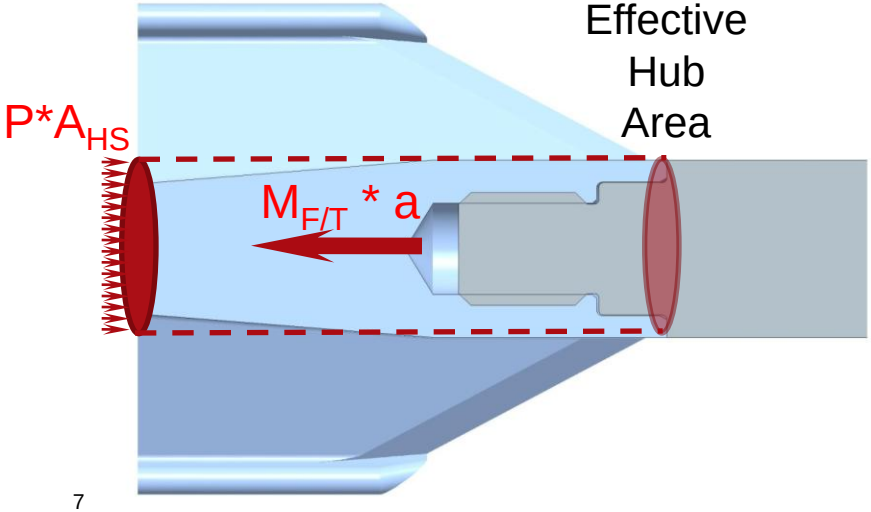
Free Body Diagrams

Intuition: Increase Joint Strength → Analysis: Improve Assembly Process

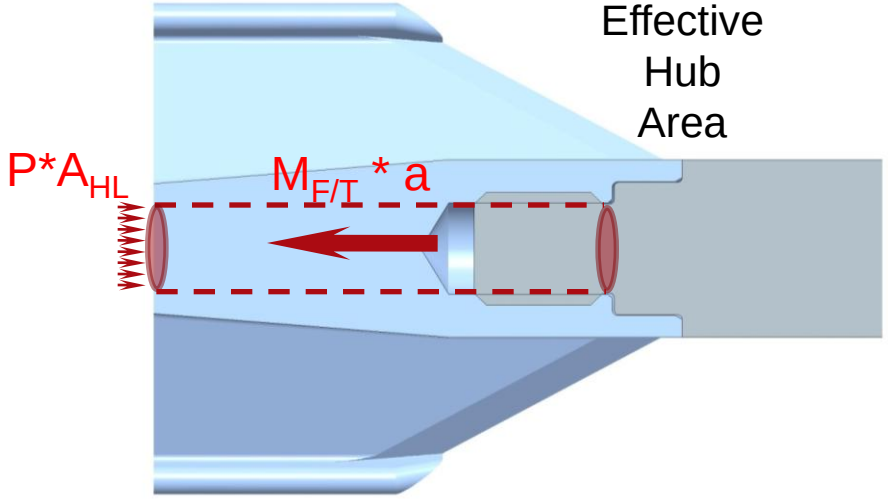
Interior Ballistic Forces



Seal Hub Forces



"Leaky" Hub Forces



EAPS Fin/Boom Interface

Analysis of Boom Failure: Compressive vs. Tensile

Forces acting on body

- Pulling Force: $M_{F/T} * a$
- Pushing Force: $P * A_H$

- Amin = minimum diameter of supporting structure (assumes thread are adequate)
- $M_{F/T}$ = Mass of Fin and Thread Spud
- P = Base Pressure
- A_H = Unbalanced Hub Area upon which pressure acts

For GP002

- $M_{F/T} * a$ ~ 0.093 kg * 39000 G's * 9.8 m/s2 = 35,500 N
- $P * A_H$
  - Unsealed ~ 328 N/mm2 * 47.78 mm2 = 15,700 N ** Tension ** Failure at Joint
  - Sealed ~ 328 N/mm2 * 188.7 mm2 = 61,900 N ** Compression ** Robust Joint

Hoop Stress will reduce Compressive Margin, but based on FEA, not enough to cause a problem.

Epoxy seal on fin joint sufficient to solve fin/boom failures

Pressure & Muzzle Velocity

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Test 100B
Propellant Sampling

Slow (FM4022)

Fast 1 (FM4033/21)

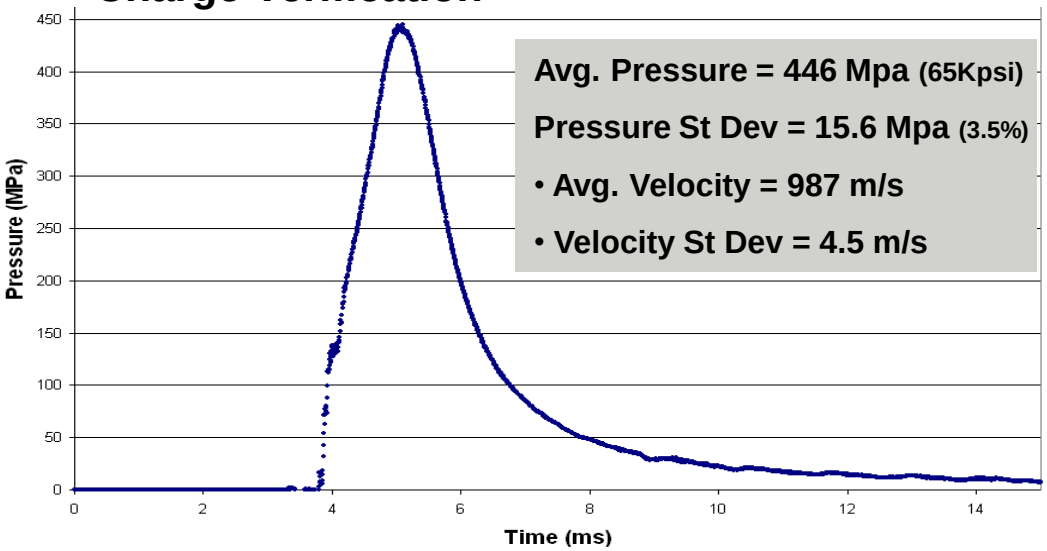
Fast 2 (FM4033/22)

Fast 3 (FM4034/22)

10% Velocity Improvement on Conventional Propellant

Test 100C
- **New Formulation**
- **Charge Establishment**
- **Charge Verification**

FM4138



Avg. Pressure = 446 Mpa (65Kpsi)

Pressure St Dev = 15.6 Mpa (3.5%)

- **Avg. Velocity = 987 m/s**
- **Velocity St Dev = 4.5 m/s**

94% of Tactical Solution.
Remainder to be Achieved Through Future Optimization

Antenna Characterization Testing

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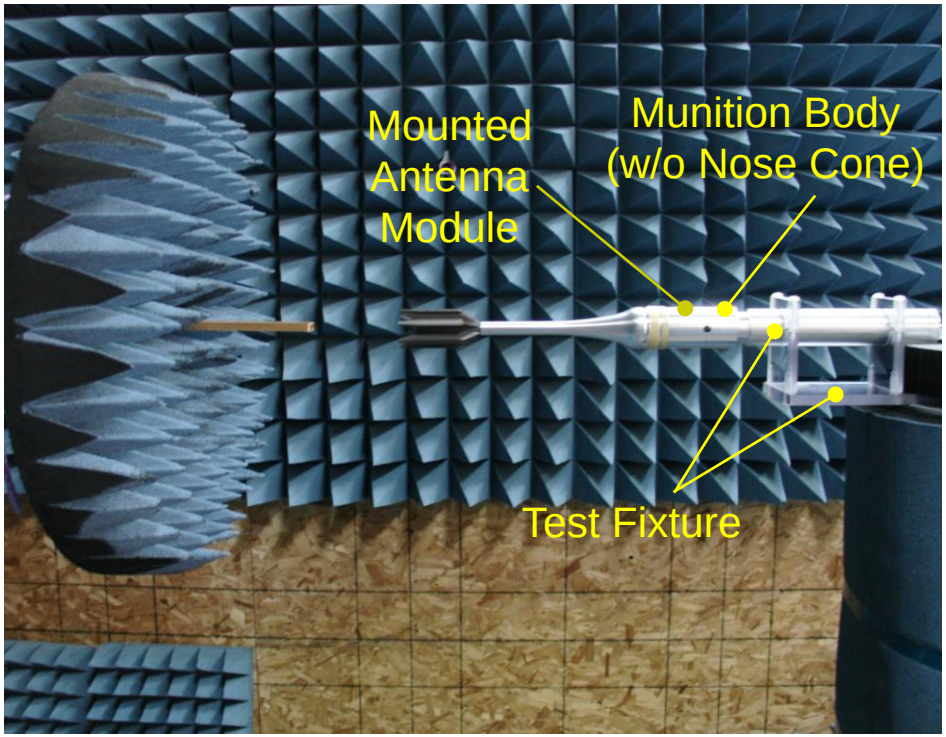
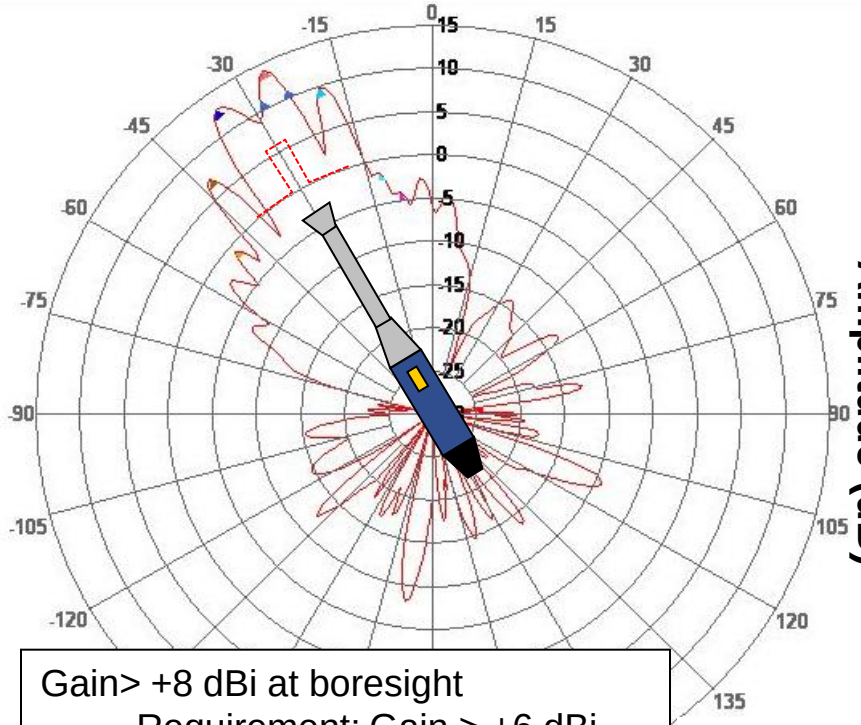
Antenna Mounted on Near-Field Test Fixture in MRC Anechoic Chamber



Measured Polar Plot at 0º Elevation and 15.950 GHz



Gain> +8 dBi at boresight
Requirement: Gain ≥ +6 dBi
VSWR < 1.6:1 over 15.7 – 16.2 GHz
Requirement: VSWR ≤ 2:1

Initial Testing Verified Significant Margin Under Most Conditions.

Excellent Directionality.

Telemetry Data

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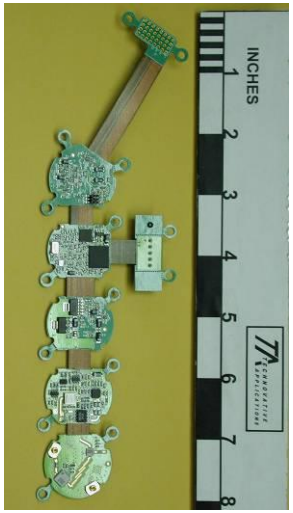
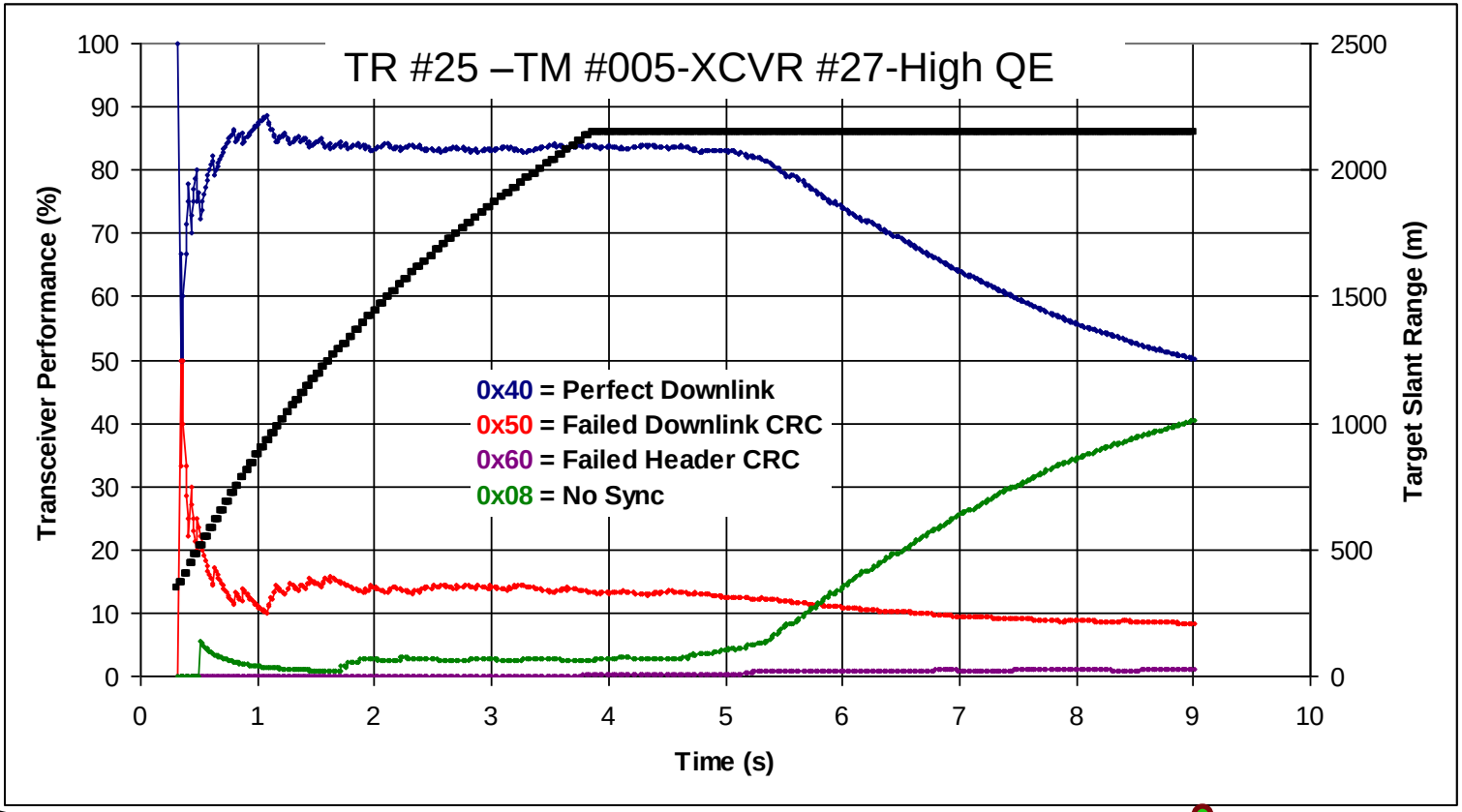
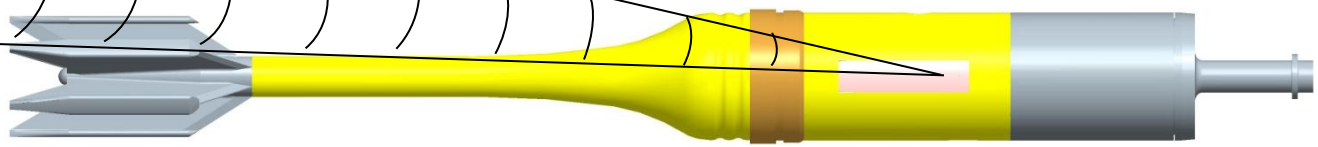
X-cvr Boards





High rate of frame transmission/reception and tracking fidelity out to impact at 2200m



Warhead Development Summary

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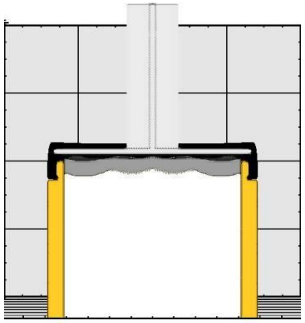
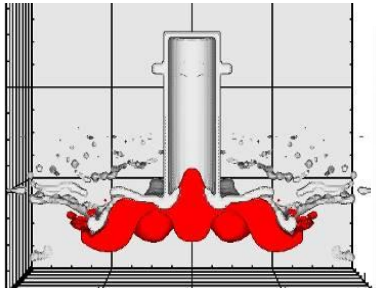
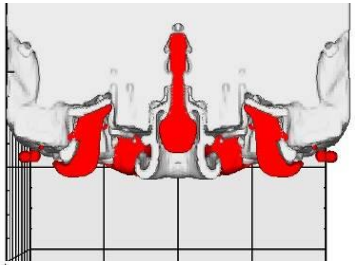
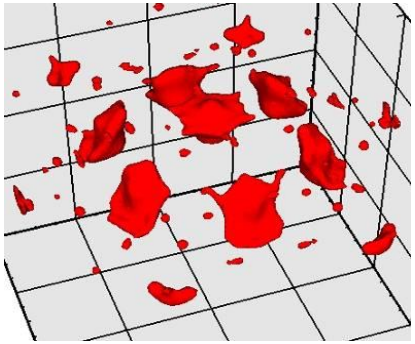
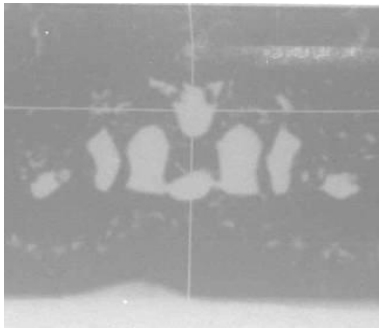


MEFP Lethal Against Rocket/Artillery/Mortar Threats

Accomplishments – Achieved Program Objectives

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EAPS Development Testing:

- ✓ EAPS Projectile Gun Launch, Interior Ballistic, and Exterior Ballistic Feasibilities.
- ✓ Incorporate Advanced Propulsion (+10% Vm)
- ✓ Command Divert of a Course Correct Projectile.
- ✓ MEFP Warhead Static & Commanded Dynamic Functionality.

EAPS Concept Demonstrations:

- ✓ ATS Radar Integration for Tracking & Communication
- ✓ 50mm Lethality Flight Demonstration (“A” Round)
- ✓ 50mm Course Correction Flight Demonstration (“B” Round)
- ✓ Prototype EAPS 50mm Automatic Cannon on Hardstand Mount

Exceeded Goals:

- ✓ Demonstrated Integrated End-to-End Tactical Functionality in Single Cartridge

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