



U.S. Army
Armament Research, Development & Engineering Center
Picatinny, NJ



120mm Line-of-Sight Multi-Purpose (LOS-MP) Munition S&T Efforts

Guns and Missiles Conference April 25th 2007

***Presented by
Jesse Sunderland LOS MP Engineer, RDECOM ARDEC***



Outline



- **Program Overview**
 - Exit Criteria
 - **XM1069 Design**
 - Process
 - Cartridge
 - Warhead
 - Fuze (XM1157)
 - Data Link
 - **XM1069 Testing**
 - Warhead
 - Structural
 - Concrete Wall
 - Anti-Personnel
 - **Conclusion**
- Modeling & Simulation*
- Test & Evaluation*





Program Overview



- **Subset of 120mm MCS and Abrams Ammunition System Technologies (MAAST) ATO**
- **LOS-MP TRL6 Exit Criteria**
 - Double reinforced concrete wall
 - Hole size 30"x50" in 3 shots or less
 - Anti-Personnel:
 - 200-700 meters Threshold
 - 40-2000 meters Objective
- **Industry Partners**
 - GD-OTS, ATK, L3

**All technical data
Government generated
& owned**



120mm LOS-MP
LINE OF SIGHT MULTI-PURPOSE



LINE OF SIGHT MULTI-PURPOSE (LOS-MP)

Present: 4 Rounds



Target Set



Future: 1 Round



Improved Lethality with Reduced Logistic Burden



LOS-MP Design Process



Decrease design time and tests

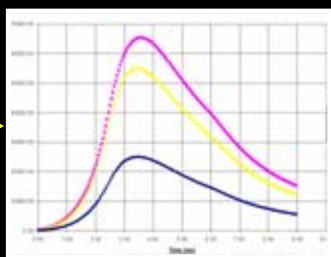
M&S Savings: \$6.8 mil/27 months

Initial conceptualization to meet requirements
Definition of high risk process and long lead items
Define shortfalls of M&S: Fill gaps with test, experience

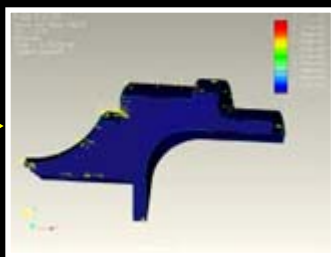
Modeling/ Configuration
Pro Engineer/ Intralink



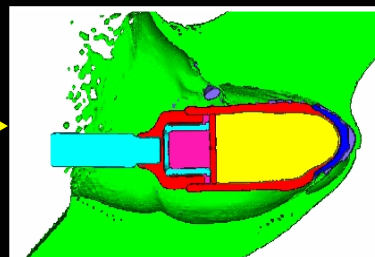
IB Simulation
IBHVG2



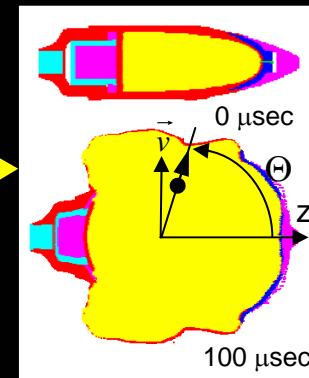
Structural analysis
FBD/ ANSYS



Target penetration
CTH



Fragmentation
CALE/PAFRAG



Failure in any model reiterates design process

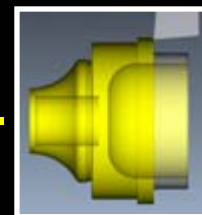
Flight Performance



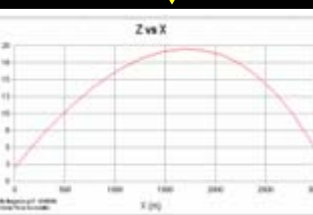
Fragmentation



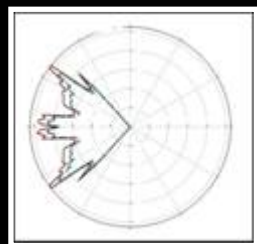
Verify models



3D numerical control
Pro Manufacture



Flight performance
PRODAS



Lethality Models
CASRED/MPR3D/
AJEM/MUVES



DR concrete wall

No iteration of design during testing !



120MM LOS-MP
LINE OF SIGHT MULTI-PURPOSE

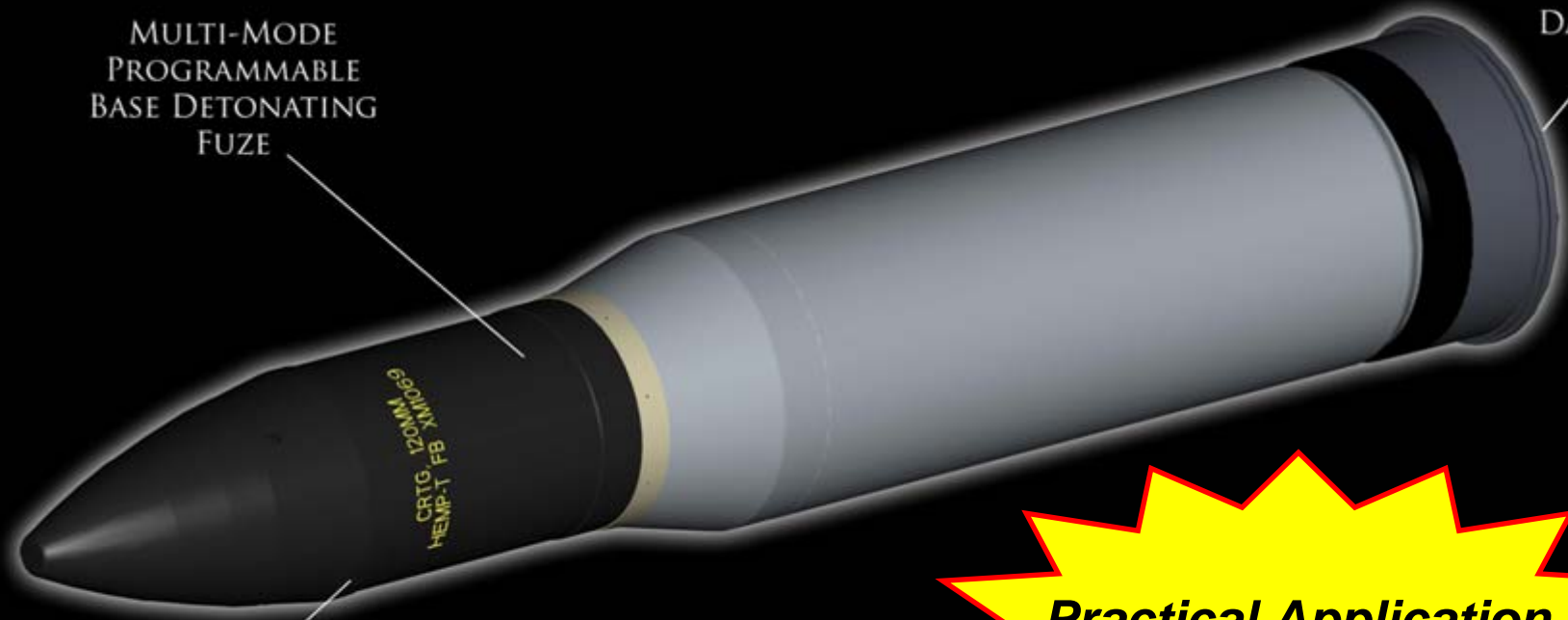


XM1069 CARTRIDGE



MULTI-MODE
PROGRAMMABLE
BASE DETONATING
FUZE

DATALINK



TARGET-PENETRATING
BLAST-FRAGMENTING
WARHEAD

**Practical Application
of
New Technology**



120mm LOS-MP
LINE OF SIGHT MULTI-PURPOSE



XM1069 Warhead Design



- **Blast fragmenting target penetrating**

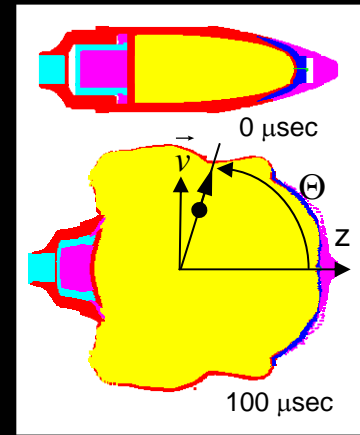
Four ARDEC Patents Pending



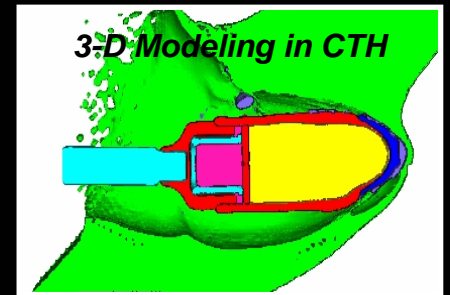
- Iteration of CTH/ CALE-PA FRAG modeling
- Structural integrity for:
 - Concrete Wall
 - Earth and Timber Bunker
- Delivers intact warhead and fuze to target sweet spot
- IM design

Fragmentation:

- ~24000 fragments



CALE/ PAFRAG predictions

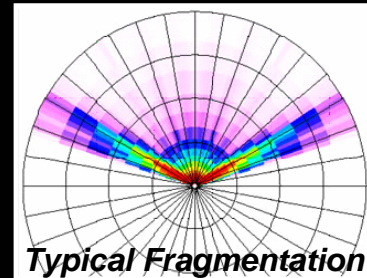


X-ray after DRC

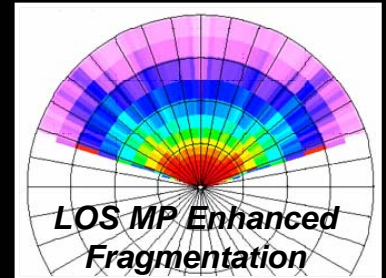
Survivable & Lethal



Loaded PAX3



Typical Fragmentation



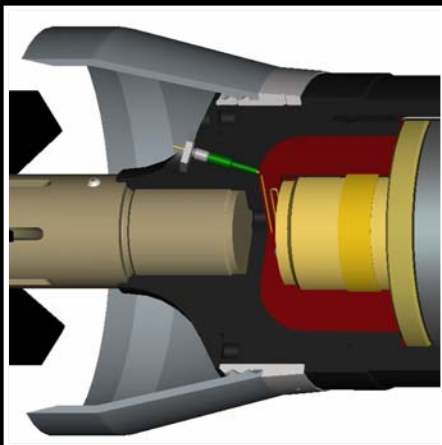
LOS MP Enhanced Fragmentation



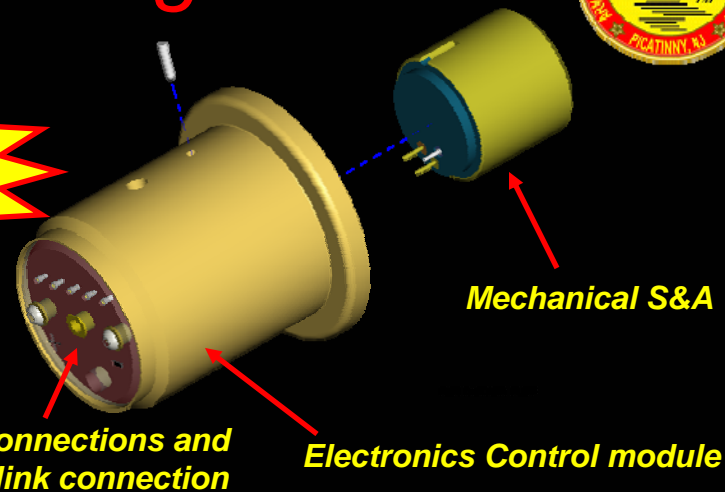
120MM LOS-MP
LINE OF SIGHT MULTI-PURPOSE



XM1069 Fuze Design



ARDEC Patent Pending



- **Multimode Programmable Base Detonating (XM1157)**

- 5 modes: 4-Point Detonate, Timed airburst
- Dual safe: Setback, commit to launch
 - 3 leaf mechanism
 - Electronically controlled piston actuator
- Power, function mode and time sent via data link
- S&A
 - No rotating contacts
 - 90 degree rotor
- Electronics
 - Dual Micro-controller
 - Enhanced Capabilities

**Preliminary
AFSRB
approval**



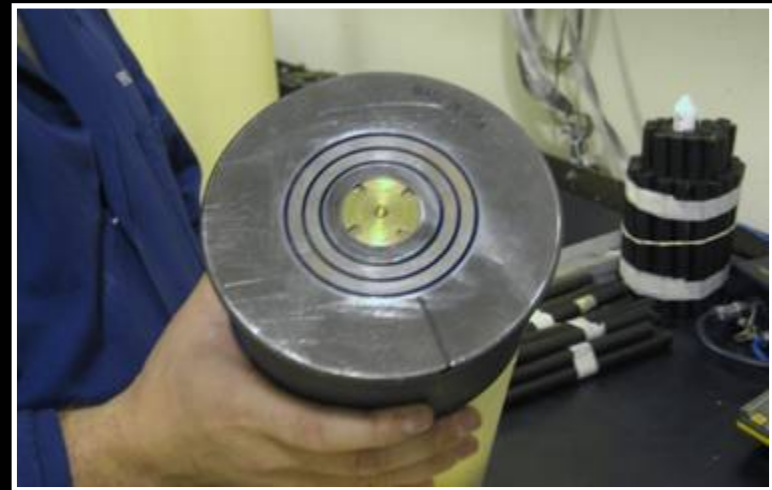
120mm LOS-MP
LINE OF SIGHT MULTI-PURPOSE



Munition Data-Link



- *Provides ability to:*
 - Power fuze
 - Set function mode & time
 - Verify data and munition status
- *Primer ignition isolated from data transmission*
- *Common Data Link for Abrams and MCS vehicles*



Utilizes production primer and case base



120mm LOS-MP
LINE OF SIGHT MULTI-PURPOSE

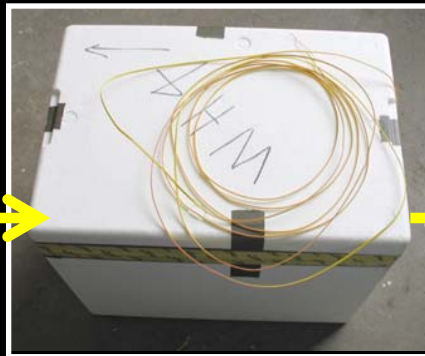


Warhead Testing: Frag Recovery



- **Fragment Recovery**

- Fragment recovery determines efficiency of warhead to produce desired fragment size and number
- Fragmentation recovery results validate and refine PAFRAG/CALE modeling data



93% fragment mass recovery was achieved



120mm LOS-MP
LINE OF SIGHT MULTI-PURPOSE

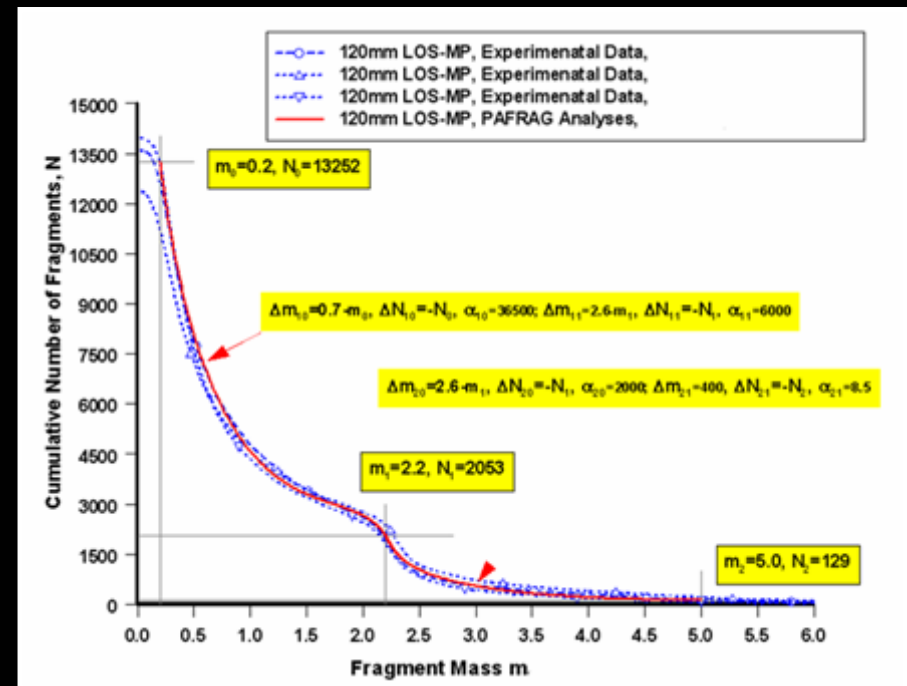
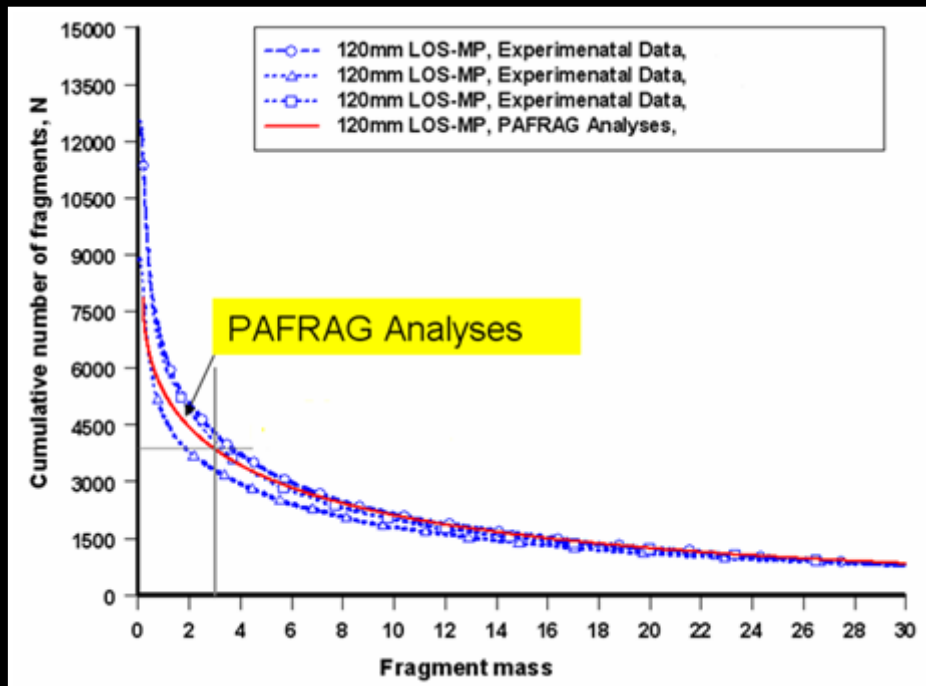


Fragment Recovery Data

Experimental vs CALE/ PAFRAG Analysis

Body Fragment # vs Mass

Nose Fragment # vs Mass



**Simulation predicted
experimentation**



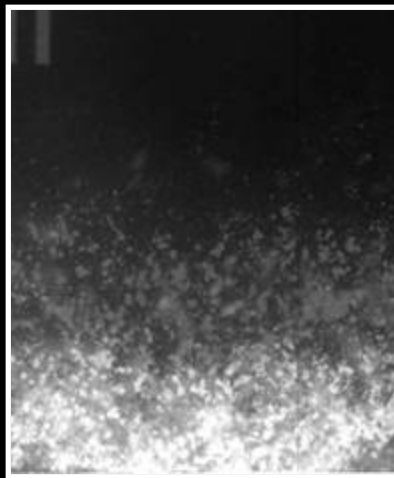
120mm LOS-MP
LINE OF SIGHT MULTI-PURPOSE



Warhead Testing: Frag Velocity



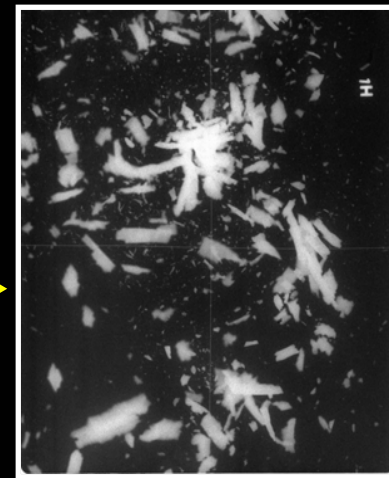
- **Fragment Velocity**
 - Determines static detonation fragment velocity
 - Fragmentation velocity results validate and refine PAFRAG/CALE modeling data



Nose Fragment Velocity
Test: 0.740 mm/ μ s
Predicted: 0.750 mm/ μ s



Fragment Velocity
Test Setup



Body Fragment Velocity
Test: 1.360 mm/ μ s
Predicted: 1.200 mm/ μ s




120mm LOS-MP
LINE OF SIGHT MULTI-PURPOSE



Projectile Structural Testing



- **XM1069 Structural Testing**

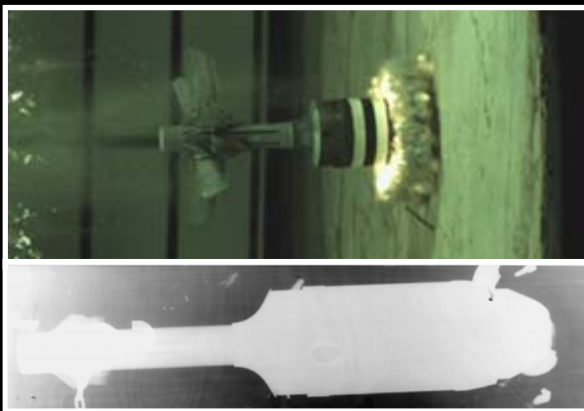
- Validate Propulsion models
- Validate FEA models → 
- Validate CTH model
- Evaluate target deceleration (for fuze programming)
 - Concrete/ Double Reinforced Concrete: Equal difficulty
 - E&T Bunker hardest on airframe



Muzzle Exit Integrity

DR Concrete Wall

Energy Decrease: 32KJ
Velocity Decrease: 60 m/s



E&T Bunker

Energy Decrease: 210KJ
Velocity Decrease: 162 m/s



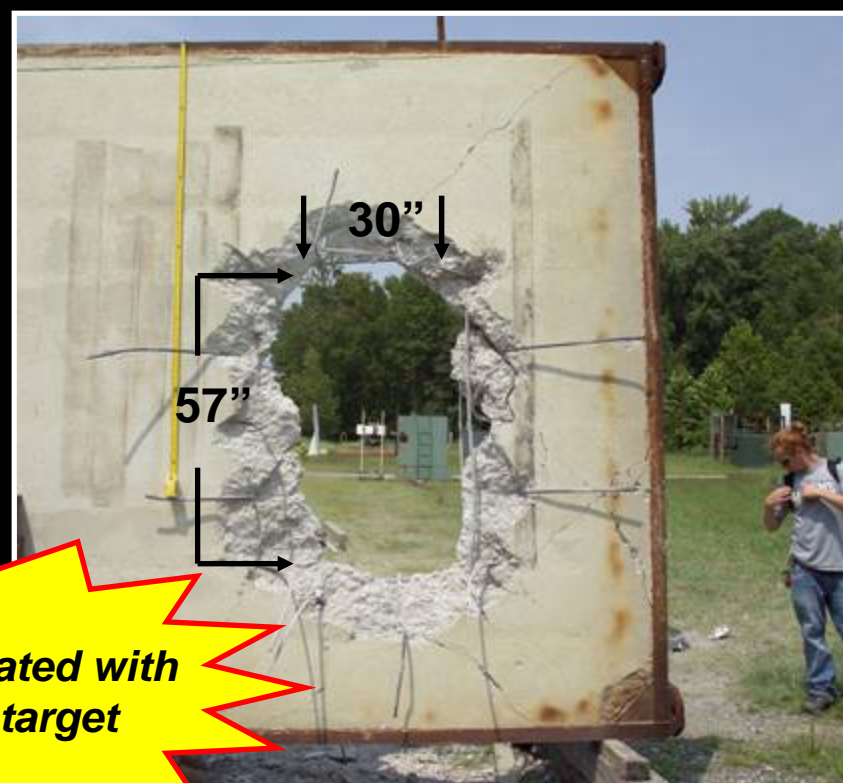
120MM LOS-MP
LINE OF SIGHT MULTI-PURPOSE



TRL6: Concrete Wall Test



- **Demonstrated XM1069 integrated with XM1157 fuze & data link**
- **Defeated target in 2 shots**



Warhead integrated with fuze defeats target

MOUT standard 8" double reinforced wall



120mm LOS-MP
LINE OF SIGHT MULTI-PURPOSE



TRL6: Anti-Personnel Test



- Demonstrated airburst performance between threshold and objective ranges



29 - 40' by 40' tarps to capture fragment spread

Demonstrated performance at 1000 meters



Sample silhouette from test:
○ Large Dots: Body frag hits
● Small Dots: Nose frag hits

Fired from Abrams SEP Tank with Data link



120mm LOS-MP
LINE OF SIGHT MULTI-PURPOSE



XM1069 Test Successes

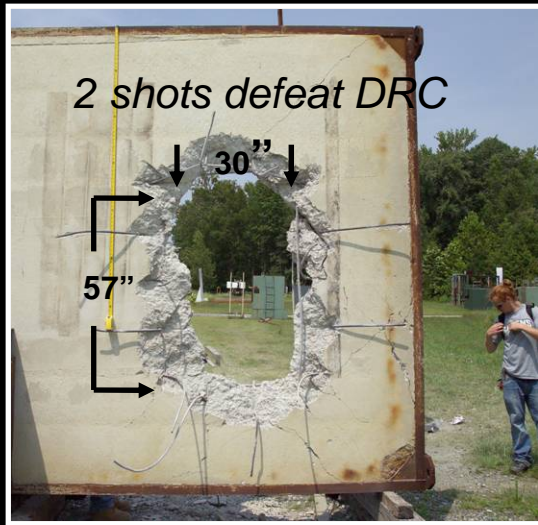


Bunker defeat 1 shot

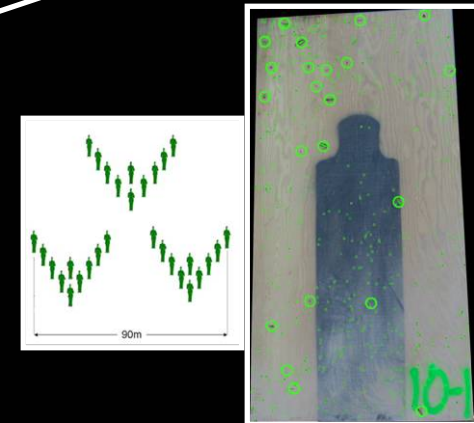
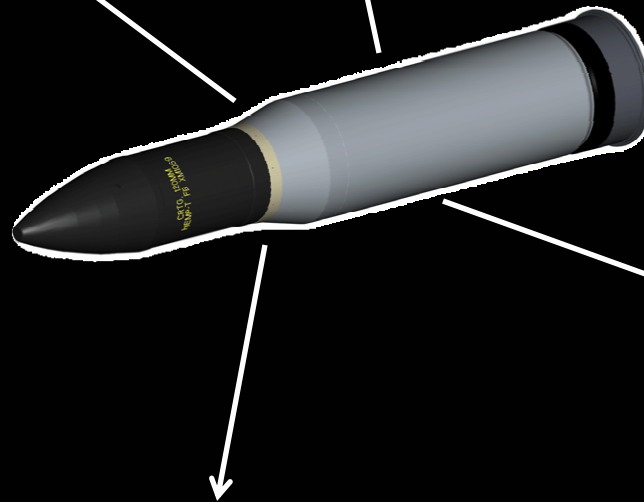
Light Armor
(Classified)



T-55 defeat 1 shot



2 shots defeat DRC



30 man platoon defeated
past 1000m



Simulated ATGM defeat 1000m



120mm LOS-MP
LINE OF SIGHT MULTI-PURPOSE

THE U.S. ARMY
ARMAMENT RESEARCH,
DEVELOPMENT, &
ENGINEERING CENTER
PRESENTS



Conclusion



- **LOS-MP TRL6 Exit Criteria has been met**

- ✓ Double reinforced concrete wall
 - Hole size 30"x50" in 3 shots or less
- ✓ Anti-Personnel:
 - 200-700 meters Threshold
 - 40-2000 meters Objective

- M&S reduced time and risk
- Testing validated and refined M&S
- LOS-MP technology ready for transition to PM-Maneuver Ammunition Systems for Advanced Multi-Purpose SDD



120mm LOS-MP
LINE OF SIGHT MULTI-PURPOSE