40th Annual Armament Systems: Guns - Ammunition - Rockets - Missiles
Conference & Exhibition
"Translating Lessons Learned into Systems Requirements"

25 -28 April 2005

Agenda

Tuesday, 26 April 2005

General Session:

- Weapons Systems and Explosives Safety in a Joint Warfighting Environment, Mr. David C. Schulte, Executive Director, Naval Ordance Safety & Security Activity
- The Future of Small Missiles, Dr. James C. Bradas, Associate Director for Missile Technology, AMERDEC

Session: Modeling & Simulation

- Accuracy Modeling of the 120mm M256 Gun as a Function Of Bore Centerline Profile, Mr. David Smith for Dr. Ronald Gast, Benet Laboratories
- Opening New “DOORS” to Managing JSF Gun System Requirements, Ms. Renee I. Bellack, General Dynamics Armament and Technical Products
- Optimized Trajectory Shaping Guidance for an Air-to-Ground Missile Launched from a Gunship, Mr. Shane Sorenson, Naval Surface Warfare Center
- Estimating Ballistic Limits of Skin and Clothing for Projectiles, Mr. Henry E. Hudgins, US Army ARDEC
- A Review of The Insensitive Munitions Design Technology Workshop, Mr. M. Pascal Marchandin, NATO-MSIAC

Luncheon:

- Super Weapons – An Analysis, LTC Simon R. West, British Army, United Kingdom Defence Academy

Session: Medium Caliber System

- Oerlikon Ammunition for New Defense Environment, Mr. Allan N. Buckley, BTECH Oerlikon Contraves Pyrotec AG
- Multi Mission Vehicle Armament & Air Burst Munition for Expeditionary Warfare Force Protection, Mr. Andrew Bradick, Lockheed Martin
- 25mm Gun Systems for theF-35 Joint Strike Fighter (JSF), Mr. Douglass C. Parker, General Dynamics Armament and Technical Products
- Optimized Gun Barrel Targeting Investigation, Mr. Jeff A. Siewart, Arrow Tech Association
- Mk 110 Mod 0 / 57mm Naval Gun & Ammunition Certification Process, LT Timothy J. Hackett, USCG, US Coast Guard Deepwater Sponsors’ Representative
- GAU-19/A Barrel Life Study, Mr. James J. St. Germain, General Dynamics Armament & Technology Products
- RNLA IFV Firepower: 30 mm versus 35 mm - 35 mm KETF Firing doctriney, Mr. Eelko van Meerten, TNO Defence, Safety & Security
- OMk44 Gun/Ammo IPT, Maj Kirk D. Mullins, USMC, DRPM AAA
- O30mm Airburst Development - Translating Lessons Learned into System Requirements, Mr. Paul A. Reynolds, General Dynamics - OTS

Wednesday, 27 April 2005

General Session:

- ATEC Update, BG(P) James R. Myles, USA, Commanding General, US Army Test & Evaluation Command
- Raytheon Missile Systems: A Global Perspective, Mr. Robert Salyer, Director, Business Development
Raytheon Missile Systems
- Acquisition and Sustainment Program, COL Lloyd E. McDaniels, USA, Project Manager, CCWS Project Office

Session: Weapon Systems

- Weapon System Concepts for a Future Gunship, Mr. Michael M. Canaday, Naval Surface Warfare Center
- Royal Navy Small Calibre Gun Research to Defeat the Small Boat Threat, Mr. Johnathan Watkins, Defence Scientific Technology Laboratory
- Mini-Typhoon Remote Operated Small Arms Mount (ROSAM), Mr. Benjamin J. Hardie, General Dynamics Armament and Technical Products
- Update on Picatinny High Speed Turret, Mr. Mr. Richard Ciekurs, US Army RDECOM-ARDEC
- 40mm CTWS Supporting UK and France, Mr. Michael Duckworth, CTA International

Session: Missles & Rockets

- Abraham Overview, Mr. Robert Daunfeldt, Bofors Defence
- Summary Overview of an Advanced 2.75 Hypervelocity Weapon, Mr. Larry Bradford, CAT Flight Services, Inc
- APKWS Flight Test Results, Mr. Larry Ingram and Mr. Dean Slocum, General Dynamics Armament & Technology Products
- APKWS Block II Demonstration Program , Mr. Milton E. (Gene) Henderson, Jr., US Army RDECOM-AMRDEC
- Missile Systems Lethality Enhancement Through the Use of a Conducting Aerosol Plasma Warhead, Mr. Allen H. Stults, US Army RDECOM-AMRDEC
- Next Generation Adaptable RF Seekers for Precision Munitions, Dr. Cory Myers, BAE Systems IEWS
- Technology for the Smart Rocket Launcher: The System Enabler For The 21st Century, Mr. Donald E. Davis, US Research, Development & Engineering Command
- Development of a Unique Penetrator Warhead for Rocket or Missile Delivery, Mr. Roger W. Melin, Lockheed Martin Missiles and Fire Control

Session: Large Caliber

- Development of the M1028, 120mm Anti-Personnel Tank Round, Mr. Hugh MacMillan, US Army Armaments Research, Development & Engineering Center and Mr. Neal Hylton, General Dynamics – Ordnance and Tactical Systems
- Metallic Materials & Processes Enabling Lightweight System Initiatives, Mr. Jeff Lehner, Director, Military Programs, Alcoa/Howmet Corporation
- Advanced Modular Gun Demonstrator: Redefining – "Faster Than A Speeding Bullet", Mr. Steve Coladonato, Applied Ordnance Technology, Inc.
- The Modified Tank Ammunition IMI M152/6 HEAT-AP- T, Mr. Danny Schirding, Chief Systems Engineer
Tank Ammunition Directorate - IMI Ammunition Group
- A105/120/125 mm PELE Firing Results, Dr. Lutz Börngen, Rheinmetall Wafe Munition
- Line Of Sight/Beyond Line Of Sight (LOS/BLOS) Advanced Technology Demonstrator (ATD), Mr. David C. Smith, P.E., USA Benet Laboratories

Session: Energetics

- Development, Evaluation and Lifetime Prediction of Medium and Large Caliber Ammunition, Mr. Gert Scholtes, TNO
- Concepts and Practices in Finding and Applying Lessons Learned, Mr. David F. Fair, US Army ARDEC
- Propellant Replacement for the 105-mm M67 Propelling Charge, Ms. Adriana L. Eng, US Army ARDEC
- Lead Azide Replacement Program, Mr. John M. Hirlinger, US Army RDECOM-ARDEC
- Modeling Efforts for Autorotation Delivery System Concept Development, Mr. David C. Rutledge, Ph.D., Staff Engineer, United Defense

Thursday, 28 April 2005

General Session:

- Direct Fire Ammunition Lessons Learned: "More Than Just Impacts on Bullets", COL Mark Rider, USA, Project Manager, Maneuver Ammunition Systems
- U.S. Army ARDEC Overview & Special Weapon Observation Reconnaissance Direct-Action System (SWORDS), Mr. Anthony Sebasto, Associate Director for Technology & Business Development, AETC
- National Defense Industrial Association (NDIA) Armament Division - 2005 Division Status, Mr. Dave Broden, Chairman, Armaments Division, NDIA

Session: Technology & Manufacture

- Automated Ammunition Identification, Mr. David F. Pouliot, United Defense L. P.
- Design for Manufacturing & Assembly (DFMA), Mr. Steve Watts, US Army RD&E Command
- ARDEC Business Development Process, Mr. David L. Burkhardt, Director, Strategic Communications, US Army ARDEC
- MEMS IMU – Common Guidance, Dr. Vicki C. LeFevre, US Army RDECOM-AMRDEC and Mr. David W. Panhorst US Army ARDEC, US Army ARDEC
- Development and Testing of High Explosive (HE) Projectiles for Electro-Magnetic Gun Army Tech Objective (ATO), Mr. Manfredi Luciano, US Army ARDEC
- Metal Injection Molding of Wing/Flaperon, Mr. Jerry C. LaSalle, Director of MIM Operations, Polymer Technologies, Inc (PTI)
- TBX Evaluation Testing in the M151 (2.75") Warhead as Risk Reduction for the APKWS, Mr. Jason C. Gilliam, US Army RDECOM-AMRDEC
- Archer Artillery Program, Mr. Ulf Einefors, Bofors Defence
- Improvements to Airborne Ladar Man-in-the-Loop Operations, Mrs. Sarah J. Hard, RDECOM-AMRDEC

Session: Mortars & Artillery

- M865 TID Improvement Study, Mr. Jason W. Gaines, General Dynamics
- Lessons Learned from the Development of the U.S. Navy 5-Inch Force Protection Projectiles, Mr. Sanford (Luke) Steelman, III, Naval Surface Warfare Center
- Advanced Gun Barrel Technologies, Dr. Amir Chaboki and Mr. Allen Boutz, United Defense
- Defining Homogeneity for Medium Caliber Ammunition and Small Grain Propellant Lots, Mr. Scott Carney, ATK
- Precision Fires for the Field Artillery, Mr. John Halvey, Raytheon, and Stefan Blomgren, Bofors Defence
- Low Cost Course Correction (LCCC) Demonstration Program, Mr. George Barnych and Mr. Daniel Davis, Ordance and Tactical Systems Division
- XM395 Precision Guided Mortar Munition (120mm PGMM): Responsive, Standoff Precision Lethality for Highly Deployable and Mobile Forces, Mr. James Terhune and Mr. Anthony Pezzano, OPM Mortars
- Precision Guided Miniature Munitions, Mr. Mark Carlson, BAE Systems
- The 81mm Non Lethal **Mo**rtar **Ca**rrier **P**rojectile (MoCaP), Mr. Seungeuk Han, Mr. Andrew Ponikowski, and Mr. Raymond Trohanowsky, US Army RDECOM-ARDEC
- Commercial Disposal of Explosive Wastes, Mr. Mark M. Zaugg, EBV Explosives Environmental Company

"Translating Lessons Learned into Systems Requirements"

40th Annual Armament Systems: Guns - Ammunition - Rockets - Missiles Conference & Exhibition

April 25 - 28, 2005

Sheraton New Orleans Hotel
New Orleans, LA

Monday, April 25 2005

10:00 a.m. On-site Registration

Noon Exhibit Move-In

5:00 p.m. - 6:30 p.m. Reception in the Exhibit Hall

6:30 p.m. Adjourn for the Day

Tuesday, April 26, 2005

7:00 a.m. On-site Registration / Continental Breakfast

7:45 a.m. Opening Remarks

8:00 a.m. ***Mr. David C. Schulte***, Executive Director, Naval Ordnance Safety & Security Activity

8:30 a.m. ***Dr. James C. Bradas***, Associate Director for Missile Technology, AMRDEC

9:00 a.m. **Session: Modeling & Simulation**

Accuracy Modeling of the 120mm M256 Gun as a Function of Bore Centerline Profile
Mr. David Smith for Dr. Ronald G. Gast, Benet Laboratories

Opening New DOORS to Managing JSF Gun System Requirements
Ms. Renee I. Bellack, General Dynamics Armament and Technical Products

Optimized Trajectory Shaping Guidance for an Air-to-Ground Missile Launched from a Gunship
Mr. Shane Sorenson, Naval Surface Warfare Center

9:30 a.m. Exhibit Hall Opens

10:00 a.m. Break in the Exhibit Hall

10:30 a.m. Conceptual Weapon System Design for the Defense of Naval Vessels from the Swarming Small Boat Threat
Mr. John E. Bibel, Naval Surface Warfare Center Dahlgren Division

Warhead Penetration Dynamics - Warhead Body, Fuze, and Target Interaction
Mr. Richard Ventura, Talley Defense Systems

Ballistic Limits of Skin and Clothing for Lethality Estimates of Projectiles Wound Ballistics
Mr. Henry E. Hudgins, US Army ARDEC

A Review of the Recent NIMIC IM Design Technology Workshop
Mr. M. Pascal Marchandin, NATO - MSIAC

11:50 a.m. Luncheon: Super Weapons From a Historical and Psycological Basis
LTC Simon R. West, British Army, United Kingdom Defence Academy

1:10 p.m. **Session: Medium Caliber Systems**

Ammunition for the New Infantry Battelfield Environment
Mr. Allan N. Buckley, BTECH Oerlikon Contraves Pyrotec AG

Force Protection - Multi Mission Vehicle Armament & Air Burst Munition for Expeditionary Warfare
Mr. Andrew Bradick, Lockheed Martin

F-35 Joint Strike Fighter Gun Overview and System Update
Mr. David L. Maher and ***Mr. Douglass C. Parker,*** General Dynamics, Armament and Technical Products

Phalanx Targeting Investigation
Mr. Jeff A. Siewart, Arrow Tech Association

3:00 p.m. Break in the Exhibit Hall

3:30 p.m. **Session: Medium Caliber Systems (Continued)**

Mk 110 Mod 0 / 57mm Gun Test & Certification Process
LT Timothy J. Hackett, USCG, US Coast Guard

GAU-19/A Barrel Life Study
Mr. James J. St. Germain, General Dynamics Armament & Technology Products

Calibre Choice for the Dutch IFV
Mr. Eelko van Meerten, TNO Defence, Safety & Security

The Expeditionary Fighting Vehicle, How Operational and Combat Lessons Learned Apply to the EFV and the 30MM Mix of Tomorrows Warfighter
Maj Kirk D. Mullins, USMC, DRPM AAA

30x173mm HEAB-T Development and Lessons Learned
Mr. Paul A. Reynolds, General Dynamics - OTS

5:30 p.m. - 7:00 p.m. Reception in the Exhibit Hall

7:00 p.m. Adjourn for the Day

Wednesday, April 27, 2005

7:00 a.m. On-site Registration / Continental Breakfast

7:45 a.m. Opening Remarks

8:00 a.m. ***BG (P) James R. Myles, USA***, Commanding General, US Army Test & Evaluation Command

8:45 a.m. ***Mr. Robert Salyer***, Raytheon

9:10 a.m. Acquiring and Sustaining US Army Missiles
COL Lloyd E. McDaniels, USA, CCWS Project Office

9:30 a.m. Exhibit Hall Opens

9:45 a.m. **Session: Medium Caliber Systems (Continued)**

Recent Developments of the M230 30MM Chain Gun
Mr. Lawrence A. Mason, ATK Ordnance & Ground Systems

MK44 Automatic Cannon Update
Mr. Mark McMillian, ATK Ordnance Systems

10:30 a.m. Break in the Exhibit Hall

Concurrent Sessions

10:50 a.m. **Session: Weapon Systems**

AC-130U Gun System Production Re-Start
Mr. John G.. Fletcher, General Dynamics Armament and Technical Products

Weapon System Concepts for a Future Gunship
Mr. Michael M. Canaday, Naval Surface Warfare Center

Royal Navy Small Calibre Gun Research to Defeat the Small Boat Threat
Mr. Johnathan Watkins, Defence Scientific Technology Laboratory

11:50 a.m. - Lunch

1:00 p.m. **Session: Weapon Systems (Continued)**

Remote Operated Small Arms Mount (ROSAM)
Mr. Benjamin J. Hardie, General Dynamics Armament and Technical Products

Placing Gunner's Behind the Proctective Armor of Vehicles
LTC Kevin P. Stoddard, USA, PM Soldier Weapons

Picatinny High Speed Turret (PHIST)
Mr. Richard Ciekurs, US Army RDECOM-ARDEC

Session: Missiles & Rockets

Critical Asset Defense - ABRAHAM Rocket Assisted Projectile
Mr. Robert Daunfeldt, Bofors Defence

Hypervelocity Propulsion System Substantially Improves 2.75 Rocket Lethality, Safety, Survivability
Mr. Larry Bradford, CAT Flight Services, Inc.

APKWS Flight Test Results
Mr. Larry S. Ingram, General Dynamics Armament and Technical Products

APKWS Block II Demonstration Program
Mr. Milton E. (Gene) Henderson, Jr., US Army RDECOM-AMRDEC

Lunch

Session: Missiles & Rockets (Continued)

Missile System Lethality Enhancement Through the Use of Pulsed Power and Plasma Conduction
Mr. Allen H. Stults, US Army RDECOM

Next Generation Adaptable RF Seekers for Precision Munitions
Dr. Cory Myers, BAE Systems

The Smart Rocket Launcher as the Key Enabler for the Rocket System of the Future: The Technology Developments Needed for the Next Generation Rocket Laucher to Carry 70mm Rockets into the 21st Century
Mr. Donald E. Davis, US Army Research, Development & Engineering Command

	Session: Weapon Systems (Continued)	Session: Missiles & Rockets (Continued)
	Recent Activities Involving 40mm CTWS in Support of UK and France ***Mr. Michael Duckworth***, CTA International	Development of a Unique Penetrator Warhead for Rocket or Missile Delivery ***Mr. Roger W. Melin***, Lockheed Martin Missiles and Fire Control
	The Marine Corps Expeditionary Fire Support System (EFSS): A Systems Overview ***Mr. Jason Burkett***, General Dynamics	Determining the Army Aviation Rocket and Missile Mix for the Future Fight ***Mr. William M. Mulholland***, Whitney, Bradley & Brown
2:40 p.m.	Break in the Exhibit Hall ***(Last Opportunity to Visit Exhibits)***	Break in the Exhibit Hall ***(Last Opportunity to Visit Exhibits)***
3:00 p.m.	Exhibit Hall Closed	Exhibit Hall Closed
3:10 p.m.	**Session: Large Caliber**	**Session: Energetics**
	Development of the XM1028, 120mm Anti-Personnel Tank Round ***Mr. Hugh MacMillan***, Armaments Engineering and Technology Center, ***Mr. Peter Georgantzis***, US Army ARDEC, and ***Mr. Neal Hylton***, General Dynamics-OTS	Advanced Propelling Solutions Complying with Demands (FCS) ***Dr. Beat Vogelsanger***, NITROCHEMIE Wimmis AG
	Titanium Investment Casting Weapon System Application ***Mr. Jeff Lehner***, Director, Military Programs, Alcoa/Howmet Corporation	Development, Evaluation and Lifetime Prediction of Medium and Large Caliber Ammunition ***Mr. Gert Scholtes***, TNO
	Advanced Modular Gun Demonstrator - XLT Test Gun ***Mr. Steve Coladonato***, Applied Ordnance Technology, Inc.	Concepts and Practice in the Application of Lessons Learned ***Mr. David F. Fair***, US Army ARDEC
	The Modified Ammunition, Equipped with the "Fuzaman": The IMI 105-mm Heat-AP-t Cartridge M152/6 ***Mr. Danny Schirding***, Israel Military Industries, Ltd	Propellant Replacement for the 105-mm Artillery Propelling Charge ***Ms. Adriana L. Eng***, US Army ARDEC
	105/120/125 mm PELE Firing Results ***Dr. Lutz Borngen***, Rheinmetall Waffe Munition	Environmentally Benign Substitute Compounds for Lead Azide ***Mr. John M. Hirlinger***, US Army RDECOM-ARDEC
	Lightweight Gun Development and Testing for the Future Combat System ***Mr. David C. Smith, P.E.***, USA Benet Laboratories	Modeling Efforts in Support of PKERS Concept Development ***Mr. David C. Rutledge, Ph.D***., Staff Engineer, United Defense
5:15 p.m.	Adjourn for the Day	Adjourn for the Day

Thursday, April 28, 2005

7:00 a.m. On-site Registration / Continental Breakfast

7:45 a.m. Opening Remarks

8:00 a.m. ***COL Mark Rider, USA***, Project Manager, Maneuver Ammunition Systems

8:30 a.m. ***Mr. Anthony Sebasto***, Associate Director for Technology & Business Development, AETC

9:00 a.m. ***Mr. Dave Broden***, NDIA Armaments Division Status Overview, Chairman, Armaments Division, NDIA

9:20 a.m. Break

Concurrent Sessions

9:40 a.m. **Session: Technology & Manufacture**

Automated Ammunition Identification
Mr. David F. Pouliot, United Defense L. P.

Deep Digger Weapons System Concept
Mr. David W. Burns,US Army ARDEC

Development of Composite Launch Tubes for Shoulder Fired Weapons through Applied Science, Planning and Teamwork
Mr. Thomas P. Jacobson, Talley Defense Systems

Design for Manufacture & Assembly (DFMA)
Mr. Steve Watts, US Army RD&E Command

Technology and Manufacturing Initiatives
Mr. Dave Burkhardt, Enterprise Management Office, US Army ARDEC

Session: Technology & Manufacture (Continued)

Army MEMS Common Guidance Program
Mr. David. W. Panhorst, US Army ARDEC and ***Dr. Vicki C. LeFevre***, AMRDEC

Development and Testing of HE Projectiles for EM Gun - STO
Mr. Manfredi Luciano, US Army ARDEC

Session: Mortars & Artillery

Tank 120mm Training Ammunition: MB65 Target Impact Dispersion Study
Mr. Jason W. Gaines, General Dynamics-OTS

Lessons Learned from the Development of the U.S. Navy 5-inch Ship Self Defense Projectiles
Mr. Sanford L. Steelman, III, Naval Surface Warfare Center

ONR's Advanced Gun Barrel Technology Program
Mr. Allen Boutz, United Defense

Structural Margin Improvement on the M829A3 Projectile
Mr. Scott Carney, ATK

Session: Mortars & Artillery

Excalibur: Turning the Field Artillery into a Long Range Precision Attack Weapon System
Mr. Stefan Blomgren, Bofors Defence

Low Cost Course Correction (LCCC) Demonstration Program
Mr. George B. Barnych, General Dynamics Ordnance and Tactical Systems Division

Session: Technology & Manufacture (Continued)

Advanced Metal Injection Molding Technology Applications to Defense Industry
Mr. Jerry LaSalle, Polymar Technologies

11:40 a.m. Lunch

1:00 p.m. **Session: Technology & Manufacture (Continued)**

TBX Evaluation Testing in the M151 (2.75”) Warhead as Risk Reduction for the APKWS
Mr. Jason C. Gilliam, US Army RDECOM-AMRDEC

Advanced Precision Kill Weapon System
Mr. Ulf Einefors, Bofors Defence

Test Results of an Imaging LADAR Seeker for Small Missiles
Mrs. Sarah J. Hard, RDECOM-AMRDEC

Session: Mortars & Artillery (Continued)

Applying Six Sigma Principles to Implementation of the PGMM Training Concept
Mr. Anthony Pezzano, OPM Mortars

Lunch

Session: Mortars & Artillery (Continued)

Precision Guided Miniature Munitions
Mr. Mark Carlson, BAE Systems

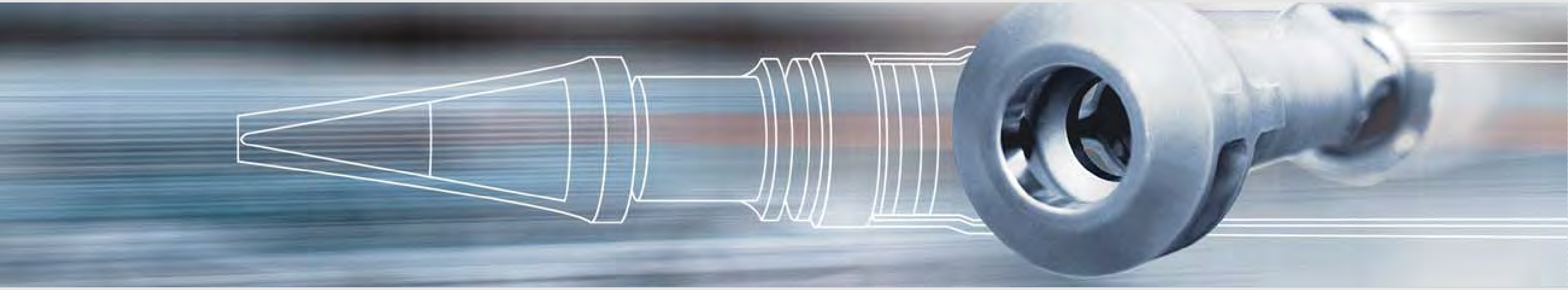
Development of a Non-Lethal Mortar Delivery System
Mr. Seungeuk Han, US Army RDECOM-ARDEC and ***Mr. Andrew Ponikowski***, US Army, RDECOM-ARDEC

Explosive Waste Recycle and Disposal
Mr. Mark M. Zaugg, EBV Explosives Environmental Company

3:00 p.m. **Conference Adjourns**

RHEINMETALL
WAFFE MUNITION

105/120/125 mm PELE Firing Results



NDIA - 40th Annual Armament Systems:
Guns-Ammunition-Rocket-Missiles Conference & Exhibition
New Orleans, LA; April 25 - 28, 2005

Dr. Lutz Börngen, Wolfgang Stein

RHEINMETALL
WAFFE MUNITION

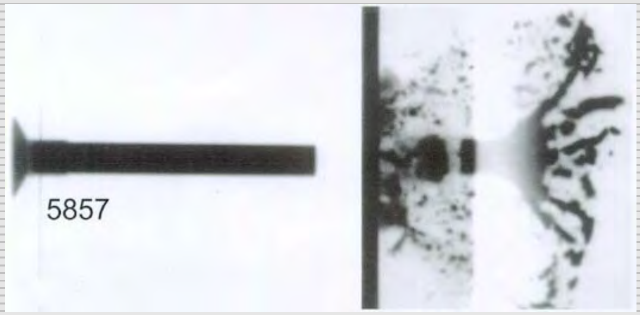
Penetrator with
Enhanced
Lateral
Effect

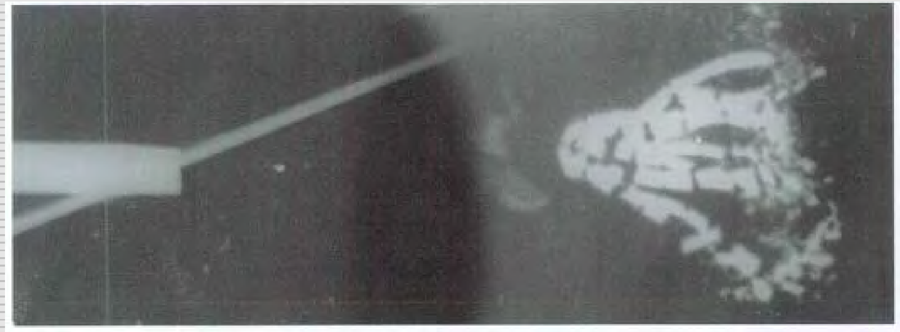
Cooperation: GEKE, ISL
Teaming Agreement with General Dynamics - OTS
Support: BWB-Germany, Royal Netherlands Army

RHEINMETALL
WAFFE MUNITION

PELE - Principle of function

- **Tungsten casing penetrates a target similar to a KE penetrator**
- **The internal medium, with a lower density, cannot penetrate the target**
- **Due to generated high internal pressure, the Tungsten casing expands and disintegrates into fragments**





Source: ISL

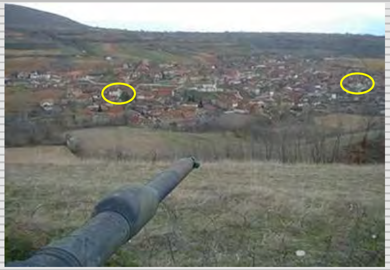
105/120/125 mm PELE Firing Results

Characteristics

KE rounds

MBT

PELE rounds

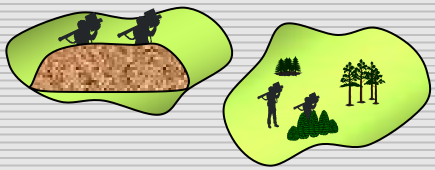


Point targets in urban areas, e.g. snipers and rocket launcher operators

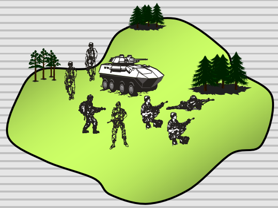
Walls and earthen targets, e.g. dugouts, sandbag barriers

Light armored or unarmored fast-moving vehicles

HE rounds



1st Priority: Guided missile positions behind / under cover



2nd Priority: dismounted infantry and light armored vehicles

Rheinmetall's idea

RHEINMETALL
WAFFE MUNITION

Use of in-service or older generation ammunition

Modify the ammunition with a goal of reducing collateral damage

If possible, increase performance in certain targets

Ammunition tested in 2002 - 2004

105 mm

- KE – PELE modified DM33
- MP – PELE modified DM68

120 mm

- KE – PELE modified DM33 A1/A2
- MP – PELE modified DM12 A1 (M830)

125 mm

- KE – PELE modified BM 15

RHEINMETALL
WAFFE MUNITION

Targets

Buildings

- Double Reinforced Concrete - 200 mm (8") - STANAG 4536
- Clay Brick Wall - 450 mm (18")
- Double Reinforced Concrete - 200 mm with Container

Light armored vehicles

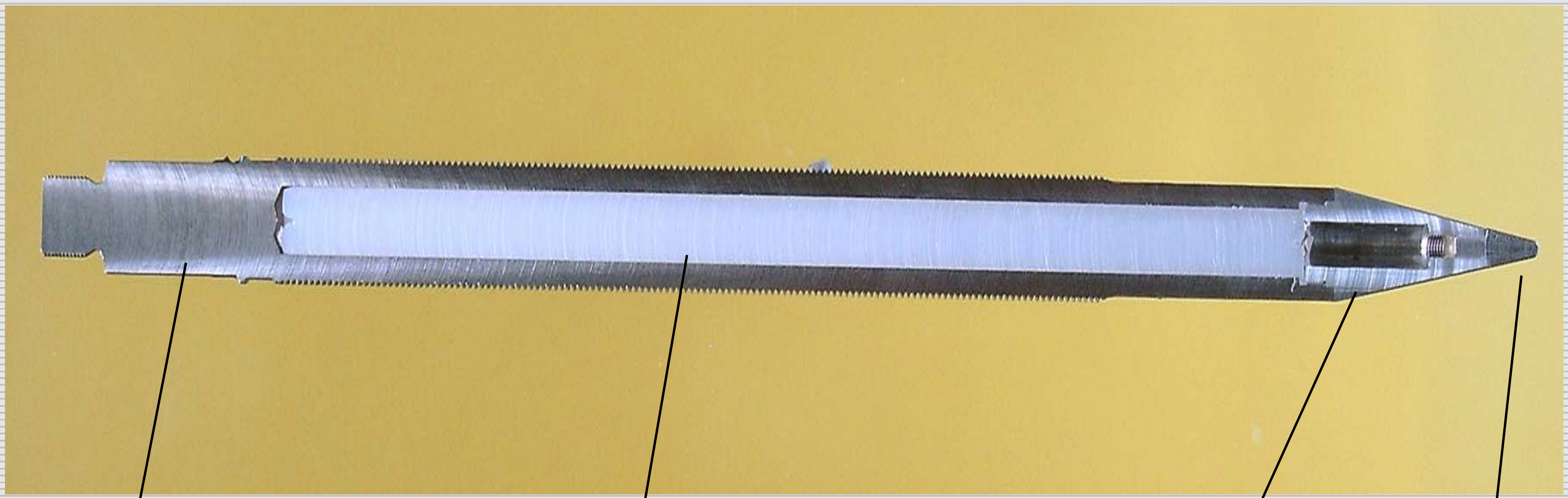
- Spaced RHA Target - 10mm at 60° NATO
- RHA Target - 100 mm at 60° NATO
- Armored Observation Vehicle (former Jagdpanzer Cannone 90 AT)
- Other NATO targets

Firing positions - snipers

- Sand Bag Wall - 500 mm (20")
- Trunk - 400 mm (16")

120 mm DM 33 KE - PELE

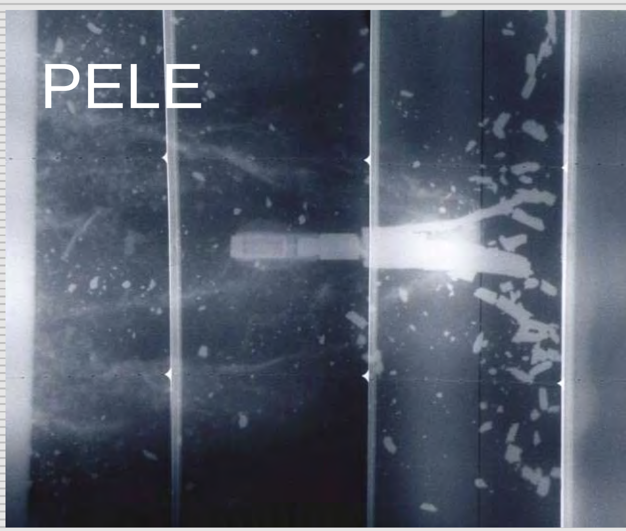
Sectional view of the PELE-Penetrator



120 mm DM 33 KE - PELE

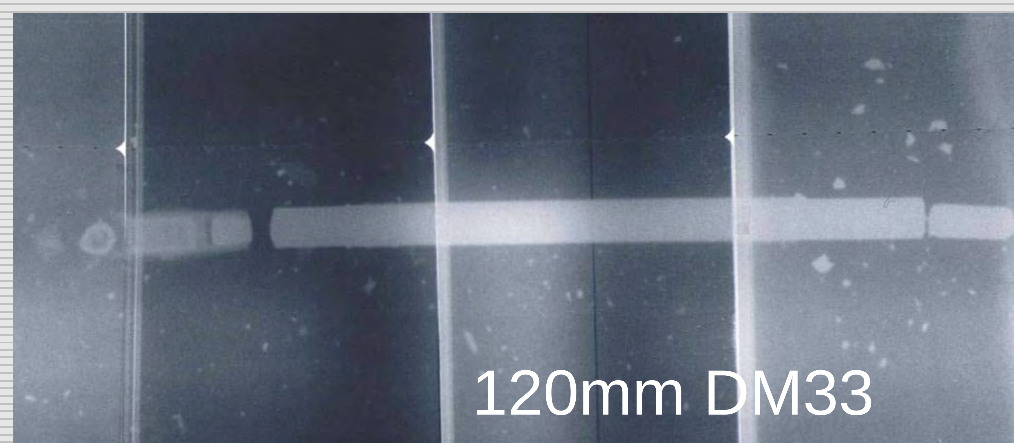
RHEINMETALL
WAFFE MUNITION

200 mm Double Reinforced Concrete



PELE: distinct dismantling into many fragments

KE: fractures at predetermined points at tip and screwed joint of stabilizing fins, penetrator remains unbroken, few fragments from the tip of the penetrator and concrete fragments



X-ray 500 mm behind target

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WAFFE MUNITION

120 mm DM 33 KE - PELE

200 mm Double Reinforced Concrete with Container

120 mm DM 33 KE - PELE

200 mm Double Reinforced Concrete with Container

Rear side of concrete inside the container

Performance of fragments and overpressure inside the container:

Large destruction inside container with <u>Minimum Collateral Damage</u>

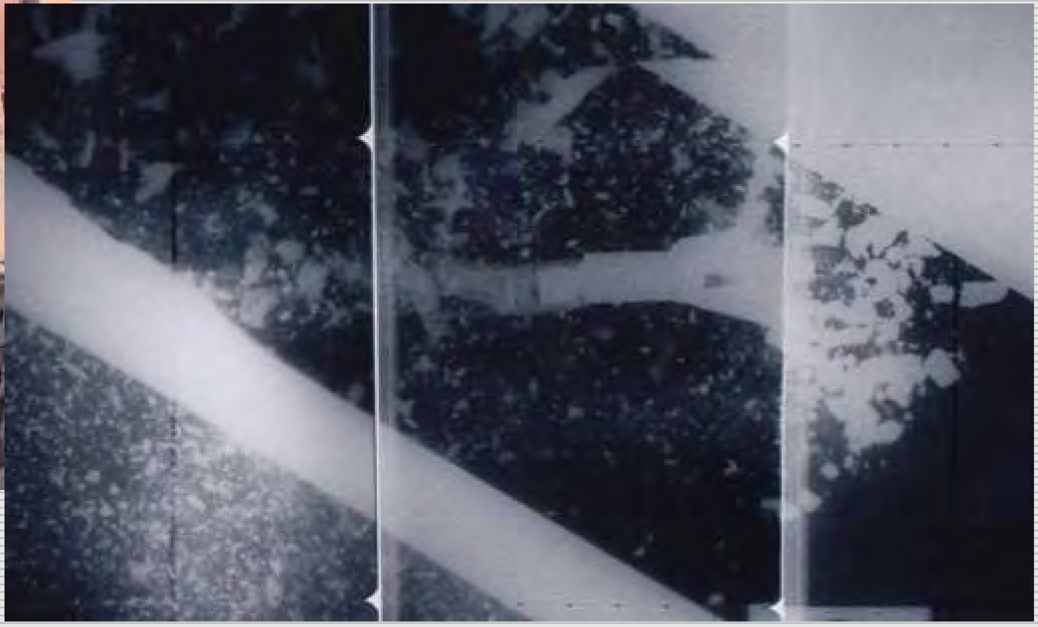
120 mm DM 33 KE - PELE

RHEINMETALL
WAFFE MUNITION

Spaced RHA Target at 60° NATO (4 x 10mm)

Target arrangement

X-ray: Penetrator & fragments behind target



105/120/125 mm PELE Firing Results

120 mm DM 33 KE - PELE

RHEINMETALL
WAFFE MUNITION

100 mm RHA Target at 60° NATO

Due to fragmentation of the PELE, the hole diameter is increased compared to a KE-penetrator and the energy of the PELE is totally absorbed by the target and contributes to its destructive power.

Only little of the energy of the KE penetrator is absorbed by the target.

After penetration, the KE penetrator still has a large residual amount of kinetic energy

105/120/125 mm PELE Firing Results

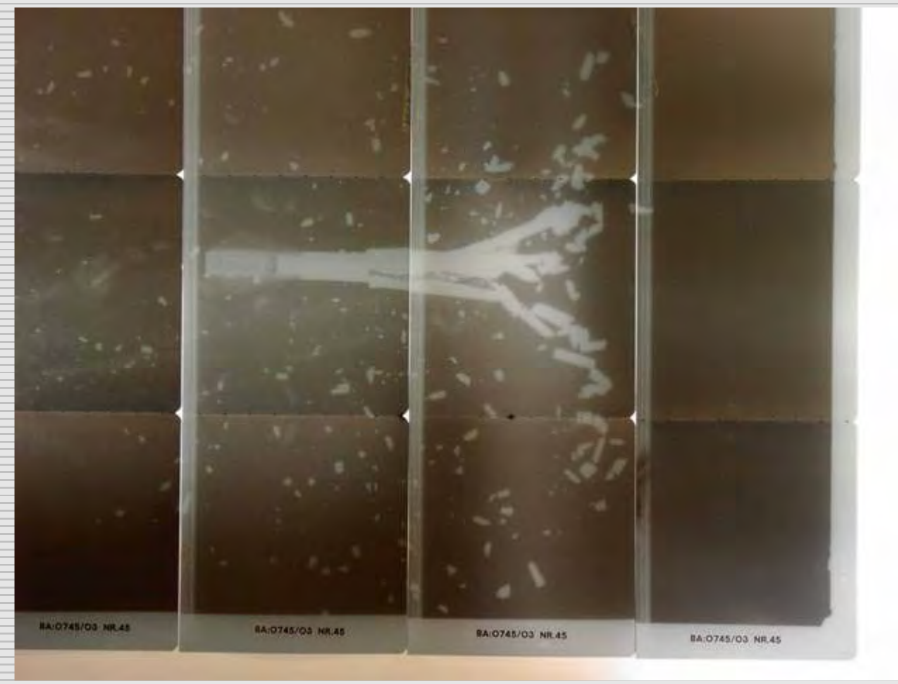
RHEINMETALL
WAFFE MUNITION

120 mm DM 33 KE - PELE

450 mm (18”) Clay Brick Wall

Front

Rear



X-ray: 500 mm behind target

105/120/125 mm PELE Firing Results

RHEINMETALL
WAFFE MUNITION

MP - PELE

120 mm

Modified HEAT – DM12 A1

105mm

Modified Training Round DM68

120 mm MP - PELE

200 mm Double Reinforced Concrete

Impact of the 120 mm MP-PELE at the concrete wall

120 mm MP - PELE

RHEINMETALL
WAFFE MUNITION

200 mm Double Reinforced Concrete - US Specifications

Three rounds provide an opening in the wall for the infantry

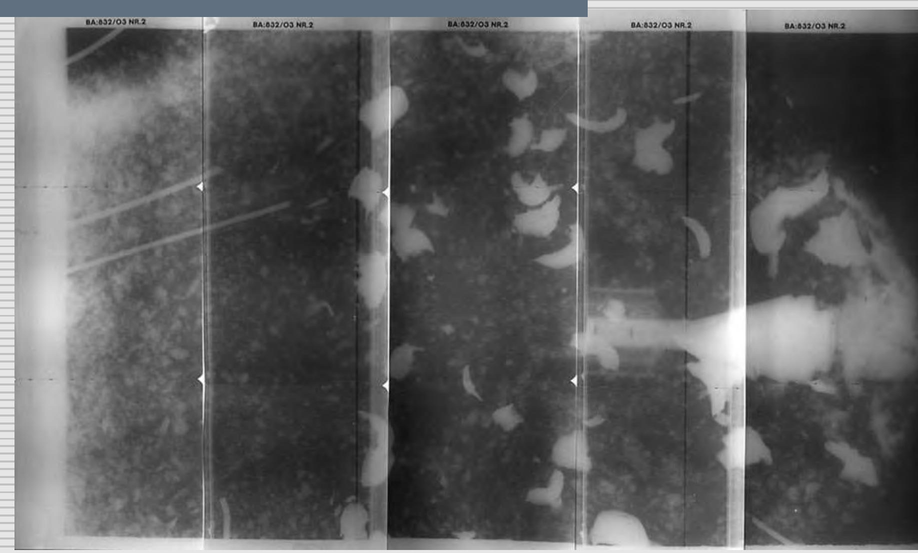
105 mm MP - PELE

RHEINMETALL
WAFFE MUNITION

200 mm Double Reinforced Concrete – US Specifications extracted from Mobile Gun System ORD

Front

Rear



X-ray: 500 mm behind target

Diameter of the hole ~ 500 mm (20”)

105 mm MP - PELE

RHEINMETALL
WAFFE MUNITION

Armored Observation Vehicle

RHEINMETALL
WAFFE MUNITION

Summary

- **Test of PELE-ammunition in the calibers 105/120/125 mm - full- and subcaliber Projectile**
- **PELE-function shown at a variety of targets from a clay brick wall to heavy armor plate**
- **PELE ammunition offers a possibility of precise and effective engagement of several targets in MOUT (Military Operations in Urban Terrain) with a Minimum of collateral damage**
- **The new ammunition combines penetration capability with improved fragmentation effect - without any detonator and explosives**
- **The new ammunition can be used with all existing weapon systems (smoothbore and rifled cannons)**
- **Upgrade or recycling of existing large caliber ammunition (full- or subcaliber)**
- **Rapid fielding availability**

RHEINMETALL
WAFFE MUNITION

Questions

Discussions

are appreciated

RHEINMETALL
WAFFE MUNITION

120 mm DM 33 KE - PELE

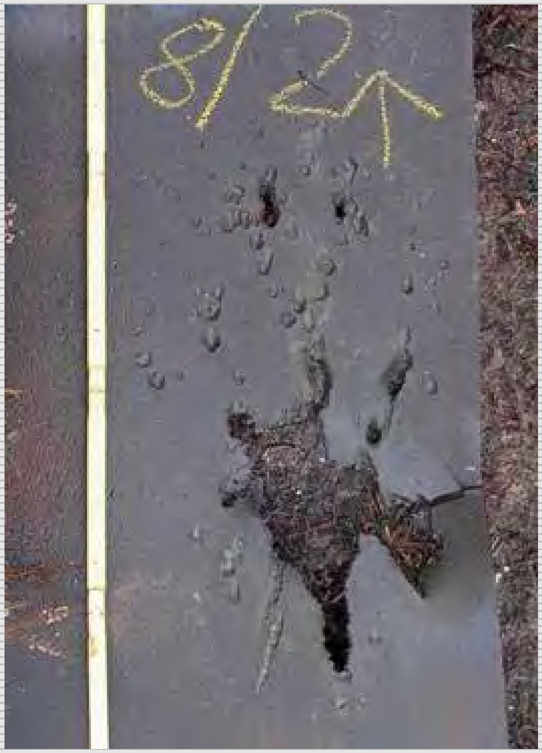
120 mm DM 33 KE - PELE

RHEINMETALL
WAFFE MUNITION

Spaced RHA Target at 60° NATO (4 x 10mm)

1. Plate (10mm)

2. Plate (10mm)



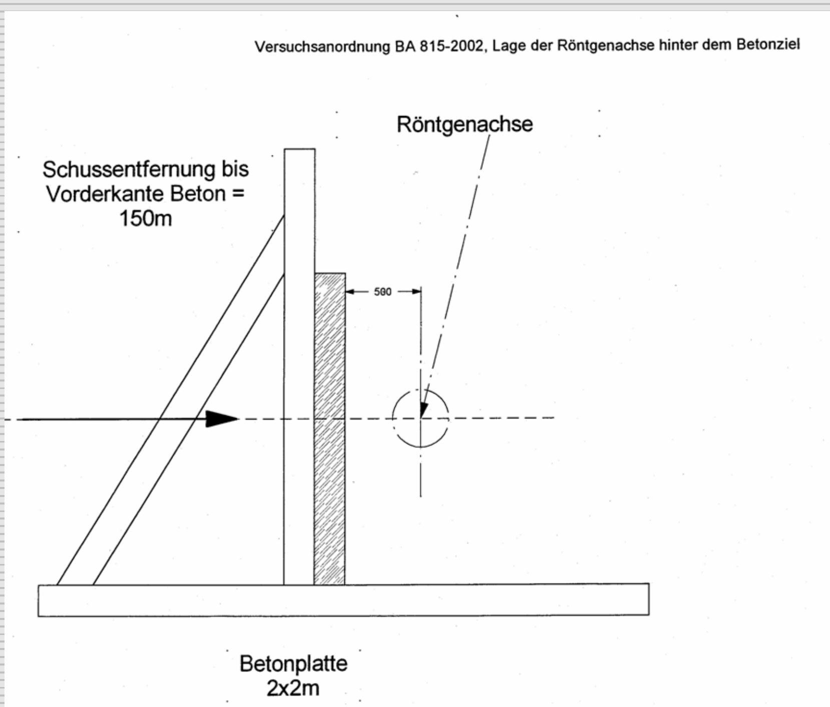
The disintegration of the penetrator at the first plate leads to a wide-spread impact (approx. 0.8 m x 0.8 m; 31" diameter) on the second plate

105/120/125 mm PELE Firing Results

RHEINMETALL
WAFFE MUNITION

120 mm DM 33 KE - PELE

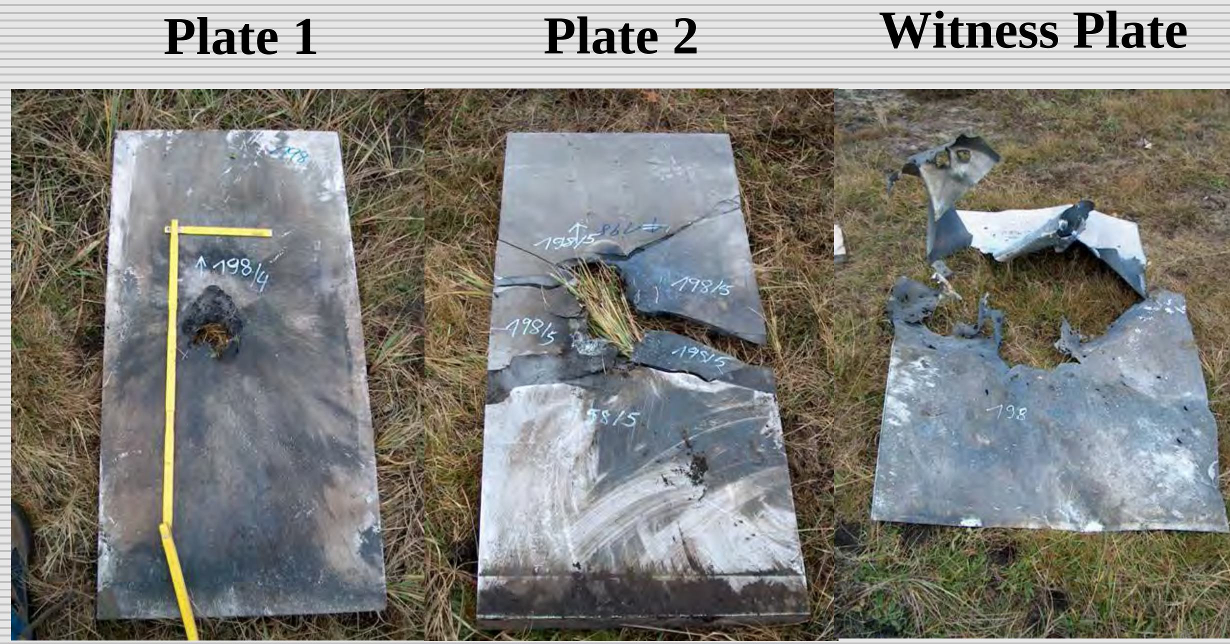
200 mm (8”) Double Reinforced Concrete



120 mm DM 33 KE - PELE

RHEINMETALL
WAFFE MUNITION

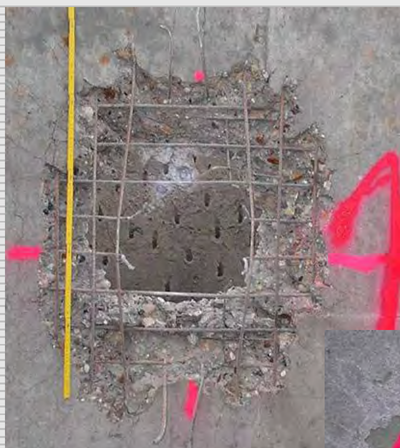
Target TGL 15 B1 - Armored Infantry Vehicle



120 mm MP - PELE

RHEINMETALL
WAFFE MUNITION

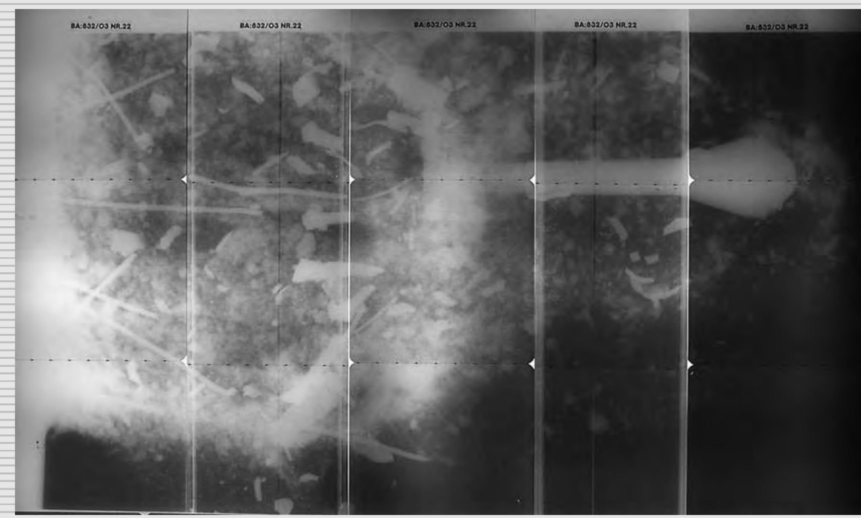
200 mm Double Reinforced Concrete



Front

Diameter of the hole ~ 600 mm (24”)

Rear



X-ray: 500 mm behind target

RHEINMETALL
WAFFE MUNITION

125 mm BM 15 KE - PELE

105/120/125 mm PELE Firing Results

RHEINMETALL
WAFFE MUNITION

125 mm KE - BM 15 - PELE

Complete 125mm BM15-PELE round
- **main propellent charge on the right**
- **incremental propelling charge with the PELE-projectile assembly on the left**

PELE-projectile in flight, 9m after leaving the muzzle

105/120/125 mm PELE Firing Results

RHEINMETALL
WAFFE MUNITION

125 mm KE - BM 15 - PELE

Effect on closed rooms (i.e. 20 ft. Steelcontainer) after penetrating a 10mm RHA-Plate 60° NATO

CAT
Flight Services, Inc.

PERSUADER

HYPERVELOCITY ROCKET

CAT
Flight Services, Inc.
2400 Bob Wallace Ave.
Suite 203
Huntsville, Al.   35805
256-650-5122
bradford.cat@mindspring.com

Visit our website at www.catflight.com

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INTRODUCTION

- This presentation provides a Summary Overview of an advanced 2.75 Hypervelocity Weapon developed in the private sector with private funding

- The technology was leveraged from a U.S. Army Missile Command Hypervelocity Rocket Technology Development program

- Superior accuracy and lethality, coupled with safety and durability offer state-of-the-art capability with an extremely low Cost/Kill from existing launchers/platforms

- Multiple K.E. Penetrator Warheads provide lethal capability against an extremely wide variety of threats

- The Weapon is a Non-Developmental Item, ready for Certification/Production and Combat Operations

PERSUADER BACKGROUND

- **Army "SPIKE" Program (1980's) demonstrated hypervelocity rocket (HVR) performance and lethality**
  - Used multi-penetrator warheads
  - 1.9" diameter
  - Lightweight composite motor case/composite propellant

- **CAT formed an industry team to leverage this technology into a 2.75" (70mm) HVR motor with KE Penetrator warheads**
  - Successfully flown from HYDRA-70 launcher (composite propellant and composite motor case)
  - Industry funded and passed certified insensitive munitions test (MIL-STP-2105B)
  - HERO compliance certified by U.S.Navy and U.S.Army
  - Successfully passed MICOM-requested worst-case environmental test sequence (temp, shock, vibration and thermal shock)
  - 900 penetrator KE warheads successfully flown

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PERSUADER 2.75 INCH ROCKET SYSTEM DEVELOPMENT TEAM

CAT Flight Services	Team Lead, System Design/Engineering/Integration, Kinetic Energy (KE) Penetrator Warhead Design, Component Manufacturing, Final Assembly, Test Direction/Support Company Lead: Larry Bradford
Atlantic Research Corporation	Propellant Mixing/Loading, Nozzle Manufacturing, Motor Static Testing Company Lead: Steve Rockwood/Charlie Clarke
Lincoln Composites	Composite Motor Case Manufacturing Company Lead: John Bomberger
Teledyne Metalworking Products	KE Warhead Tungsten Penetrator Manufacturing Company Lead: Dr. Steve Caldwell

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The PERSUADER was Technology Leveraged From MICOM-SPIKE Hypervelocity Technology Development Program

(1978 - 1990)

- **SPIKE Lightweight Composite Motor (1.9”) development/flight demonstration**
  - Single one-pound KE Penetrator
  - 130 flight tests
- **SPIKE Multi-Penetrator warhead development/flight demonstration (over 200 flight tests)**
  - 18 penetrators (forward release)
  - 18 penetrators (center release)
  - 80 penetrators
  - 88 penetrators
  - 100 penetrators
  - 216 penetrators
- **SPIKE Demonstrated platform compatibility**
  - Helicopter (COBRA)
  - Robotic Ground Vehicle
  - HMMV (PMS); Pedestal Mounted Stinger
- **SPIKE Demonstrated accuracy from fixed launcher: 3.2 mil CEP**

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Successful PERSUADER Development Overview & Summary Milestones

- Tri-service user survey of deficiencies/requirements
- Concept definition and system design
- Component development/verification testing
- Seven successful flight tests out of M261 HYDRA-70 launcher
  - Four with 7-pound warhead: 1490 m/s
  - Three with 10-pound warhead: 1250 m/s
- Successfully passed Insensitive Munitions (IM) Tests
  - Fast “Cook-off”
  - Bullet Impact
  - Fragment Impact
  - Sympathetic Detonation
- Successfully passed MICOM requested worst-case environmental test sequence (Jointly Funded: MICOM/CAT Team)
  - Accelerated aging
  - Shock
  - Vibration
  - Thermal Shock
  - Statically fired at temperature extremes
- Successful flight tests with 900 Penetrator warhead from M261 launch pod integrated into Hawk launcher/radar/fire control (Jointly Funded: MICOM/CAT Team)

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KE PENETRATOR
WARHEAD DEVELOPMENT

- PERSUADER Team supported MICOM and developed five multiple-penetrator warhead designs

- PERSUADER Team also supported over 300 flight tests of these Warheads

- Developments included single KE rod and Multi - Penetrator designs with 1, 2, and 3 bays of penetrators

- Target Menu included Anti-personnel/Air-defense, medium armor, and heavy armor (defeats tanks thru top, sides, rear, cannot penetrate frontal armor)

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…RESULTED IN SUCCESSFUL SCALE UP OF KE PENETRATOR WARHEAD

SPIKE	TECHNOLOGY	PERSUADER	
18 - 25 gram	OVER 75 Flight Tests	20 - 200 gram	HEAVY ARMOR
88/100 - 5 gram	OVER 200 Flight Tests	216 - 17.5 gram	GENERAL PURPOSE/MED. ARMOR
216 - 2 gram	OVER 40 Flight Tests	900 - 4 gram	AIR DEFENSE

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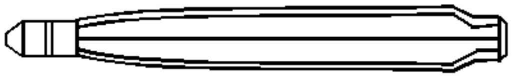
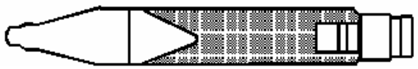
PERSUADER WARHEAD OPTIONS FOR ENHANCED VERSATILITY

Applicable Existing HYDRA-70 Warheads

M151



M229



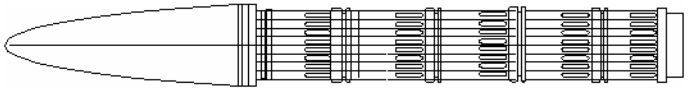
M247

Others

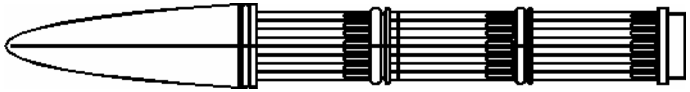
Personnel **Anti-Armor/Personnel**

New PENETRATOR Warheads

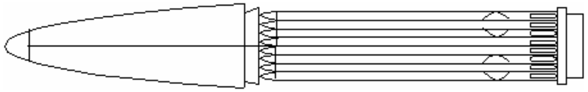
4 grams



17.5 grams



200 grams



Why are they valuable?

- Qualified and available
- Force Structure exists
- Applications and lethality established
- Training warheads are qualified and available

What does Persuader offer?

- Minimum time to target for improved survivability
- Accuracy and speed to provide increased lethality
- Accuracy, range and speed for additional applications and increased standoff
- IM compliant motor for increased safety

What do new KE Penetrator warheads offer?

- Proven lethality for air defense at extended ranges
- New capabilities to engage light-to-medium armor targets
- New capabilities for application to material and troops at longer ranges
- New capabilities for deep interdiction against bunker storage, etc.
- Capability for significant damage to heavy armor
- Inert to IM stimuli

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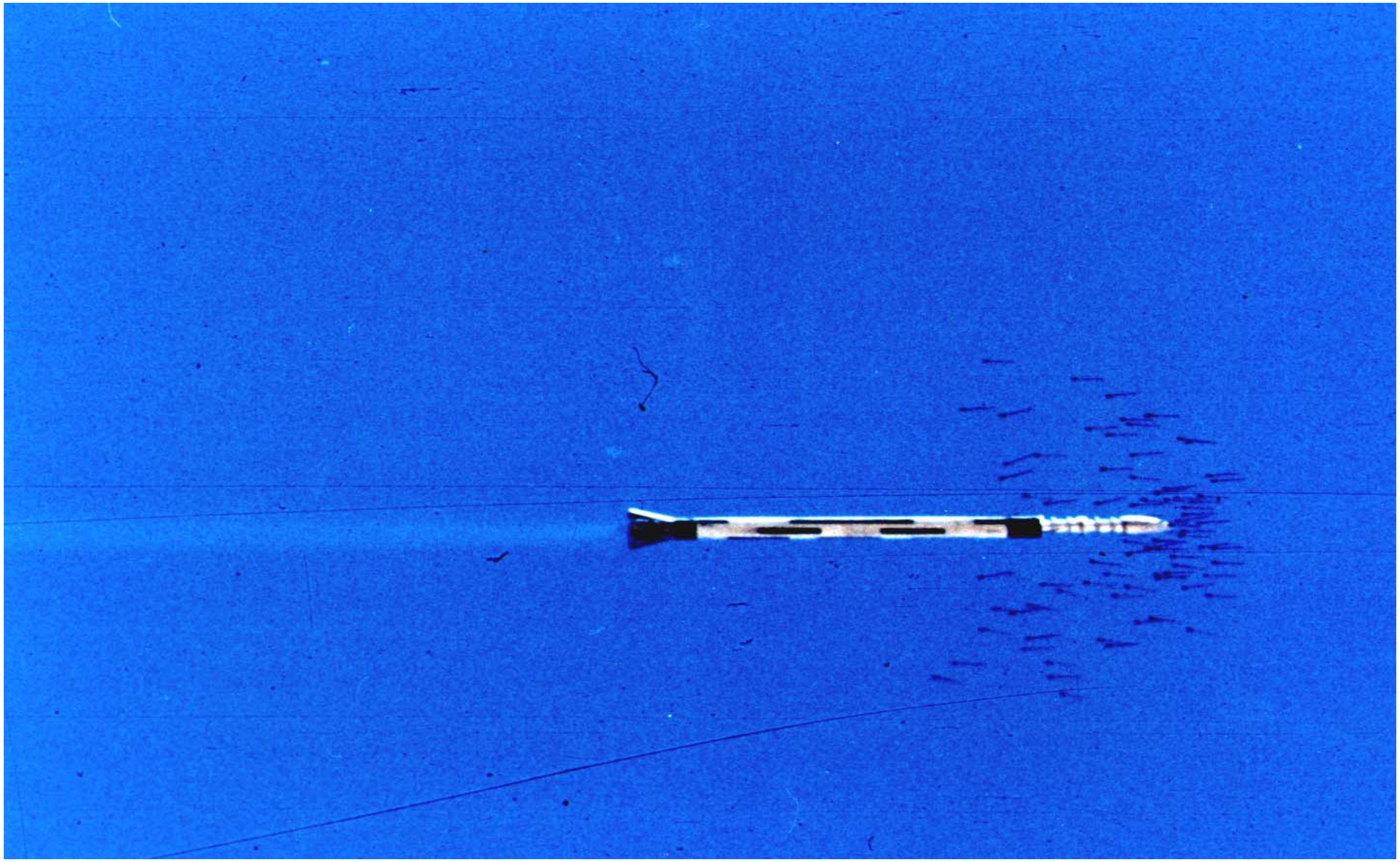
Clean (no tumble) Penetrator Release Conserves Velocity, Delivers Maximum KE on Target



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PERSUADER HYPERVELOCITY ROCKET
VERY SAFE, VERY LETHAL…….

PERSUADER is a Fully Developed State of the Art 2.75 Inch Rocket

- **COMPATIBILITY:** Compatible with <u>all</u> existing HYDRA-70 launchers/platforms
- **LETHALITY:** Dramatically superior to <u>any</u> existing 2.75 inch rocket
- **SAFETY:** <u>Exceeds</u> the CRV series and substantially <u>exceeds</u> HYDRA-70
- **COST:** Competitively priced, with a substantial <u>reduction</u> in rounds required for kill

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.....COMPATIBLE WITH EXISTING HYDRA-70 LAUNCHERS, PROVIDING THE LOWEST COST/KILL OF <u>ANY</u> 2.75 ROCKET.....

LETHALITY

- Extremely accurate delivery of Multi-Penetrator Warheads dramatically increases hit probability
- Substantially higher velocity greatly increases penetration/kill probability
- Penetrator energy <u>on-target</u> is over 300% greater than HYDRA-70

SURVIVABILITY

- Extended range capability provides increased platform standoff
- Quicker kills
- Reduced number of rounds required/kill enhances both defensive and offensive capability

<u>KINETIC ENERGY WARHEAD</u>

20 - 900 PENETRATORS

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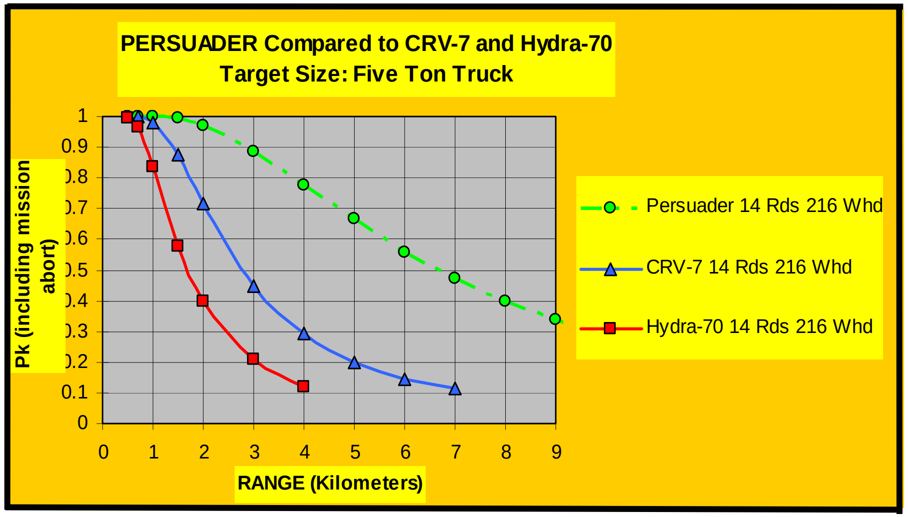
.....MINIMIZES LOGISTICS AND SUBSTANTIALLY INCREASES PLATFORM STAND-OFF.....

SAFETY

- NATO class 1.3 propellant
- Meets US specifications for HERO, EMD
- Meets MIL-2105B, U.S. insensitive munitions spec. (with exception of SCO, estimated to go propulsive based on similarity)



COMPATIBILITY

- Compatible with all launchers capable of firing HYDRA-70: mechanically & electrically (designed, demonstrated, and verified)
- Soft Launch: launch loads are well below established upper limits
- Logistics: force structure exists, standard operating procedures for HYDRA-70 apply, lowest number of rounds required/ mission
- Warheads: New KE Penetrator Warheads, but compatible with most existing HYDRA-70 type Warheads

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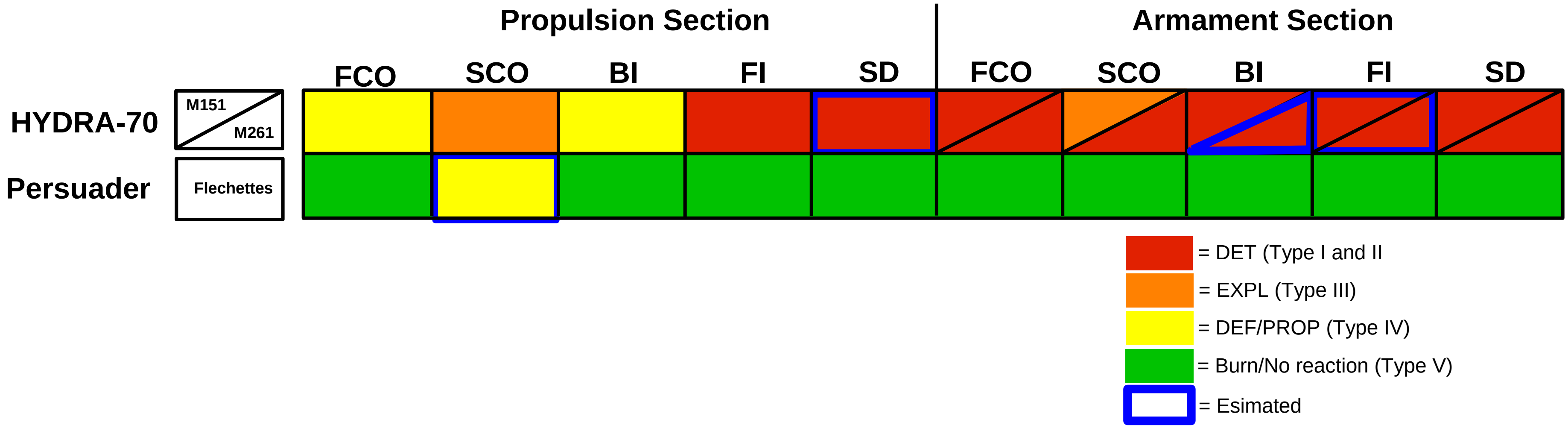
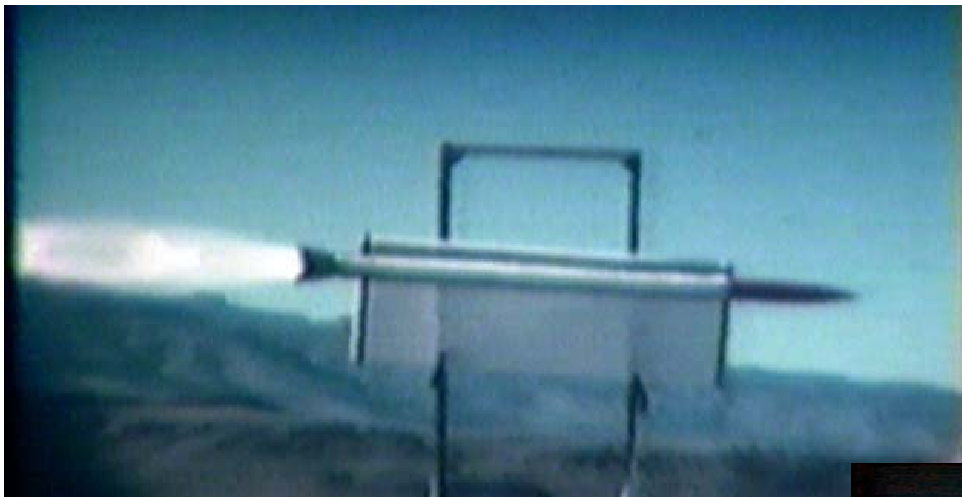
Persuader Substantially Improves 2.75 Inch IM Capability

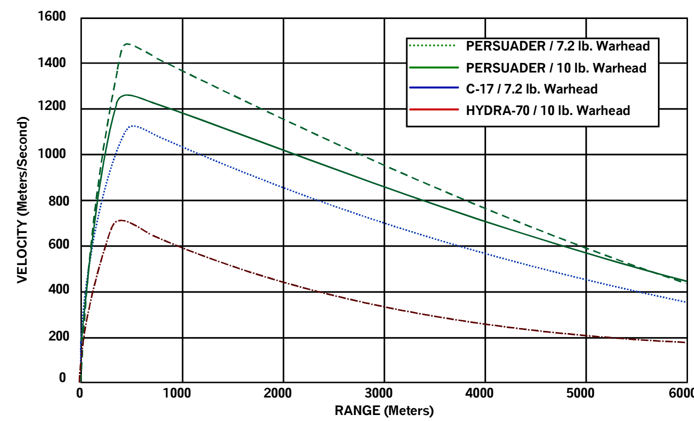


- **Persuader motor IM testing was done at Tera Socorro, NM**
  - Fast cook-off DI-SAFT-81130 S/N 22, S/N 17
  - Bullet Impact DI-SAFT-81132 S/N 21
  - Fragment Impact DI-SAFT-81133 S/N 20
  - Sympathetic Detonation DI-SAFT-81134 S/N 16, S/N 18

- **Definitions**
  - ***FCO:*** Fast Cookoff
  - ***SCO:*** Slow Cookoff
  - ***BI:*** Bullet Impact
  - ***FI:*** Fragment Impact
  - ***SD:*** Sympathetic Detonation

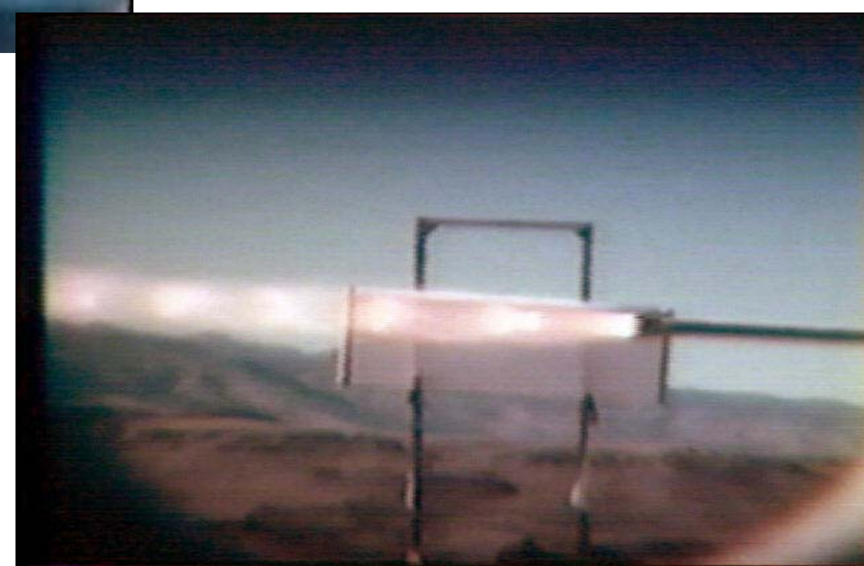
CAT ….. MINIMUM TIME-TO-TARGET RESULTS IN QUICKER KILLS, WHILE FLIGHT VERIFICATION DEMONSTRATES SUPERB VEHICLE STABILITY AND MINIMUM PLUME SIGNATURE…..





- Hypervelocity speed and superb aerodynamic stability support the weapons inherent accuracy

- Reduced smoke composite propellant not only contributes to weapon safety but provides substantially reduced plume signature



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.....FLAT TRAJECTORY, MINIMUM DISPERSION AND NO COUNTERMEASURES DRAMATICALLY ENHANCE WEAPON EFFECTIVENESS !

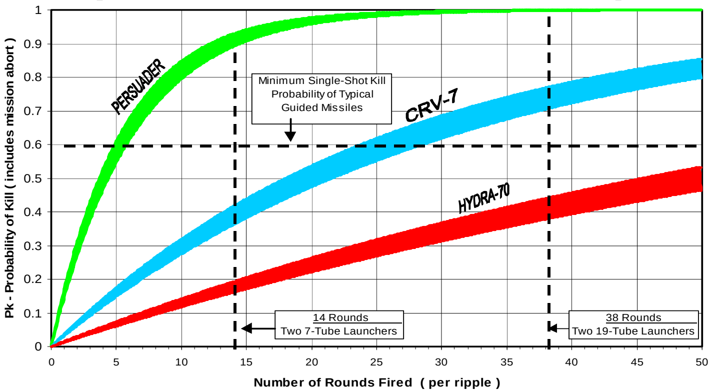
Motor Weight:	13.9 lbs
Velocity:	Warhead:
1250 m/s	10 lb
1490 m/s	7 lb

Inner Boundary: <500 meters

Maximum Range: 16 Km

Dispersion: <5 mils CEP

BROAD THREAT MENU AT 3 Kilometers
(216 Penetrator Warhead)



COST

- PERSUADER unit price is competitive with both HYDRA-70 and CRV series
- Substantial Reduction in required rounds/kill, provides the lowest cost/kill of any 2.75 weapon

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SUMMARY

- PESUADER MEETS THE NEED FOR AN IMPROVED ROCKET

HYPERVELOCITY PERSUADER PROVIDES UNIQUE ADVANTAGES

‣ Quicker Kills	…Enemy has much less time to maneuver or counter
‣ Greater Accuracy	…Much Less dispersion …Much Less wind effect
‣ Simplified Engagements	…Support Turn-and-Shoot tactics …Minimizes quadrant elevation adjustment
‣ Longer Range	…Matches improved (longer-range) sensor capabilities
‣ Greater Survivability	…Survivability significantly improved with increased stand-off
‣ Air-to-air Engagement	…NEW rocket capability
‣ Lower Cost	…Substantially higher number of stowed kills per launcher/mission

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CONCLUSIONS

DISPERSION COMPENSATING MULTI-PENETRATOR WARHEADS PROVIDE THE PERSUADER WITH UNMATCHED LETHALITY IN 2.75 INCH ROCKETS

- **THIS PROVIDES THE USER WITH SUBSTANTIALLY DECREASED COST PER KILL**
  - significantly less rockets/target
  - minimizes platform time-on-target and rounds/target
  - frees up assets faster for other missions

- **MINIMIZES LOGISTICS SUPPORT FOR WEAPON SYSTEM / PLATFORM**

- **NEW CAPABILITY IN AIR -to- AIR COMBAT**

- **IN ADDITION PERSUADER CAN USE EXISTING HYDRA-70/CRV SERIES OF WARHEADS FOR EVEN GREATER VERSITILITY**

PERSUADER……. STATE-OF-THE-ART 2.75 INCH WEAPON

Weapon System Concepts for a Future Gunship

Michael Canaday

Next Generation Gunship (NGG) Analysis of Alternatives (AoA)

The Gunship IRD Requires a Transformational Capability

Target set:

- **Enemy troops in contact with friendlies**

Capabilities:

- **Situational Awareness**
- **Precise, responsive, focused weapons effects**
- **Persistence**
- **24-hour operations**
- **Survivability**

Supports two of OSD's operational goals:

"Denying sanctuary to enemies by providing persistent surveillance, tracking and rapid engagement with high-volume precision strike, … against critical mobile and fixed targets at various ranges in all weather and terrains."

"Protect and sustain US forces in distant anti-access and area-denial environments."

AoA PSAS Enabling Technologies

- Hovering UAVs
- Common Operating Picture and Control (COPaC)
- Very Small Missile (VSM)
  - Precise, Responsive, Focused-effects Weapon
  - Prosecute multiple, simultaneous targets throughout the hemisphere under the aircraft
  - 4 inch diameter, 57 inch long; 45 pounds
  - Performance: 15 miles maximum, in 65 seconds
  - Guidance: GPS/INS (in-flight updates) + Laser seeker (optional terminal guidance)
  - Warheads: Lethal and Non-lethal
  - Cost: Approximately $18,000 each

Requirements

Requirements

- 10 to 15 nmi Range
- 360° Coverage
- Lethal
  - Enemy Personnel
  - Soft Skinned Moving and Stationary Vehicle
  - Armored Moving and Stationary Vehicle
  - Non-Hardened Structures
- Low Collateral Damage
  - Precise with Surgical Effects
- Deep Magazine = Light and Small
  - 45-50 pounds
  - 40-50 inches Long
- Affordable
  - Interservice Common Ammunition
  - Common System Components Across DoD/Commercial
- Selectable Effects
  - Modular Allowing for Guided Non-Lethal/Less than Lethal Munition Options
- Day/Night Capable
- Graceful Degradation
- Small Deployed Footprint
- Automated System

Light Armored Vehicle

Personnel

Buildings & Infrastructure

Truck

Boat

VSM Capabilities are Best Provided by a Weapon System

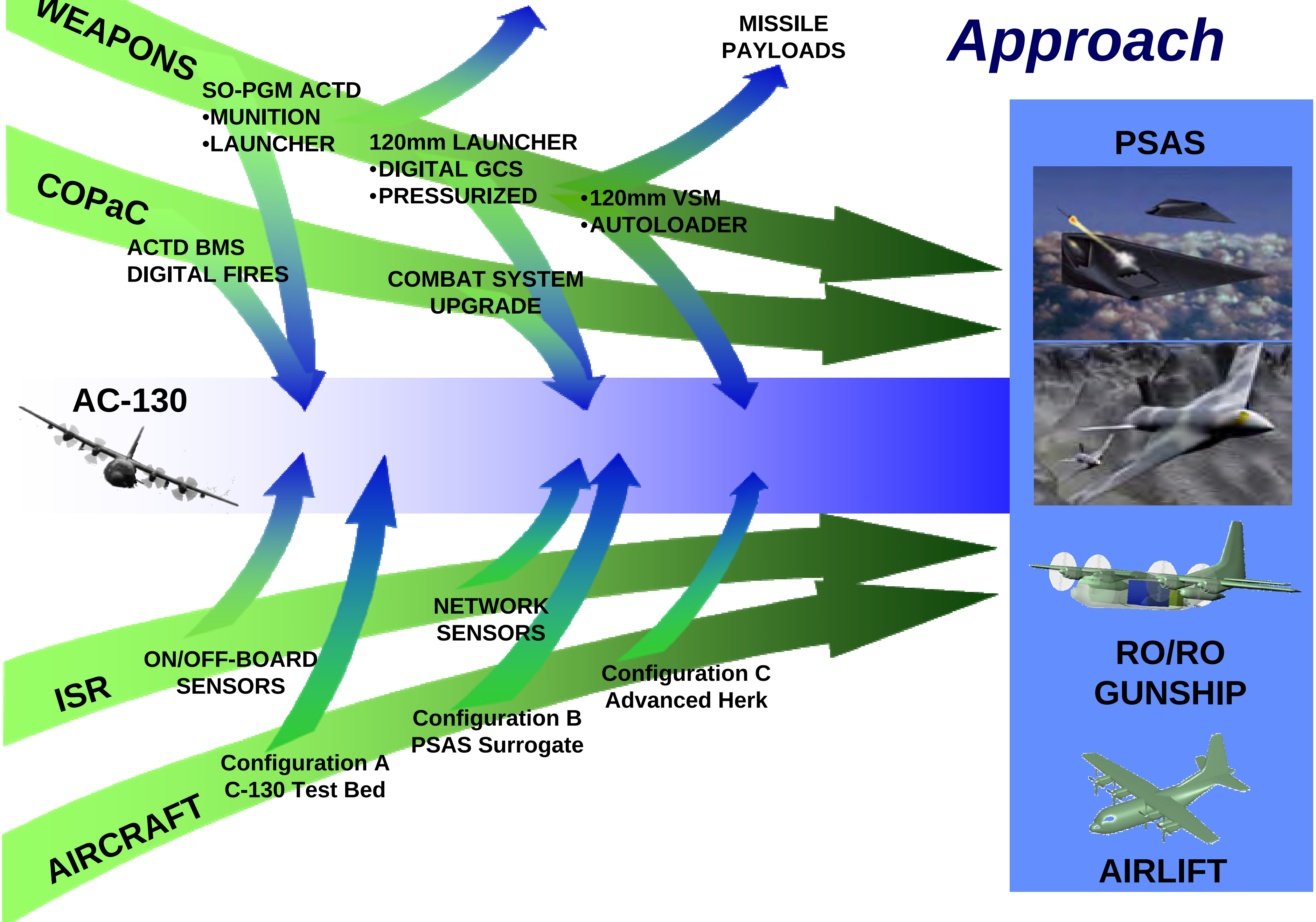
- **VSM Does Not Exist**
  - **The Capabilities of the VSM are Not Performed by Munitions that Fit the Size and Weight Requirements of the VSM**

NAVSEA WARFARE CENTERS DAHLGREN

Mr. Wynne's Challenge

Demonstrate Capabilities That Can Be Spiraled Into The Current Fleet

Overall PSAS Approach



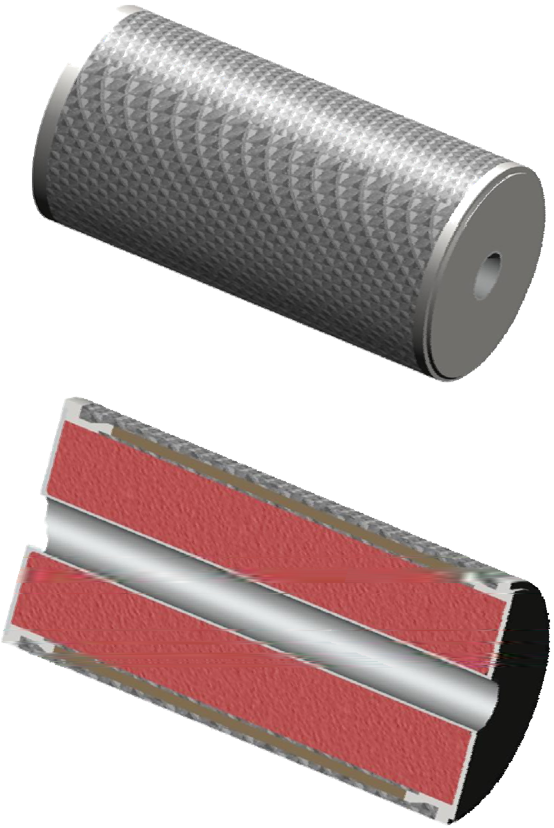
Munition / Launcher Size

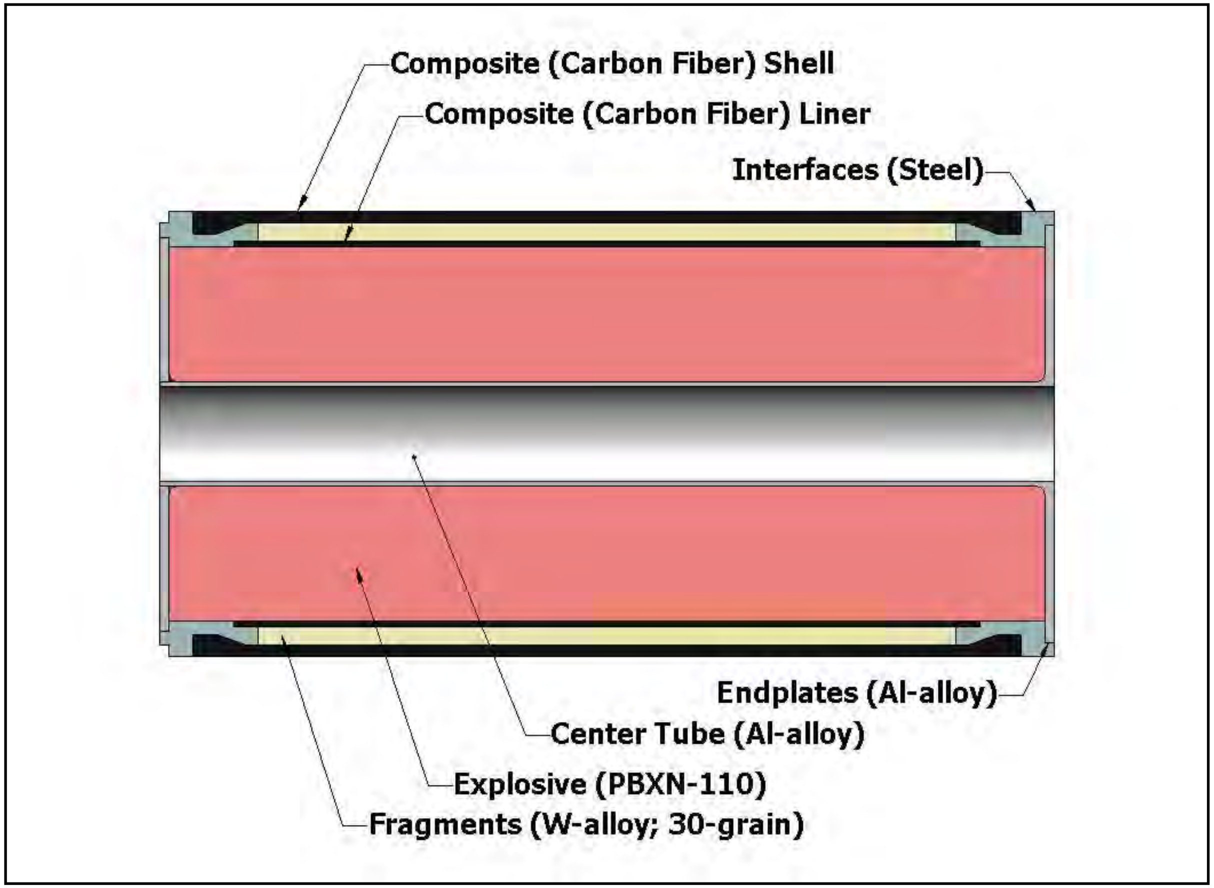
100mm < MUNITION DIAMETER <127mm

- **Munition Volume Too Small for State of the Art Guidance & Propulsion Technology**
- **Lethal Payload Size Limited**
- **Munitions Too Heavy for one man lift**
- **Launch Loads Increase to Obtain Separation Velocities**
- **Lethality Overkill**

120mm AND 105mm DIAMETER MUNITIONS ONLY COMMONLY USED SIZES IN THIS RANGE

Concept Warhead





120mm vs. 4 inch Diameter Warhead Effectiveness Summary

Munition		Accuracy CEP	HOB (ft)	Number of Shots to achieve Pk		
				Target 1	Target 2	Target 3
Baseline	**105mm (M1 MOD)**	**2 mils**	**0**	**5**	**10+**	**10+**
		2 mils	**14**	**3**	**10+**	**10+**
VSM	**Fast (120mm)**	**1.5 m**	**3**	**1**	**1**	**2**
		5.0 m	**4/5**	**1**	**1**	**3**
	Slow (120mm)	**1.5 m**	**3**	**1**	**1**	**1**
		5.0 m	**4**	**1**	**1**	**2**
	AoA VSM (4.0 in.)	**1.5 m**	**3**	**1**	**2**	**3**
		5.0 m	**4**	**1**	**2**	**7**

- **Effectiveness Studies Indicate that 120mm vs. 105mm/4 inch Diameter Warhead Designs Have Superior Performance Against Target Set**

NAVSEA WARFARE CENTERS DAHLGREN

Launcher

- Gun
- Missile
- Dispenser
- Things to Consider:
  - PSAS Must Stay Within Geographic Location of High Priority Mission
    - Orbit is Not Necessary for Gun Fire Control - Allows for Short Range Use of Unguided Rounds
    - Less Expensive Munitions Can Be Used if Less Guidance Control Authority is Required (GPS Guided Artillery Rounds)
  - Gun Launch is a Well Proven Method of Deploying Munitions from Inside Aircraft
  - VSM-Like Munitions are Launched Out of Guns and Missile Launchers
  - Rocket Propelled Munitions Cannot Be Safely Ignited Inside of Aircraft
    - What if They Don't Leave?
  - Rocket Exhaust Plumes Burn Aluminum movie
  - Fully Maneuvering Rocket Propelled Munitions are Expensive - Use Only When Needed
  - Unguided Munition are Cheap – Use IF You Can

VSM must be developed in the context of an overall PSAS Combat System

105-mm GUN vs. 120-mm MORTAR

105-mm Howitzer

- Weight 100 rounds 4200 lbs
- Recoil Load: ~10,900 lbs
- Gun Recoiling Weight 1,465 lbs
- Muzzle Pressure: 3,560 psi
- Legacy System
- Little Guided Technology Ongoing
- Lethal Payload Size
- Current System Too Much Gun
- FCS 105mm Gun is Separate Loaded

120-mm Breech Loaded Mortar

- Weight 100 Rounds 3200 lbs
- Recoil Load: ~5,600 lbs
- Gun Weight 1,315 lbs
- Muzzle Pressure: 1,620 psi
- Leading FCS Fire Support Weapon
- Stryker Brigade Combat Team Fire Support Weapon
- A Lot of Guided Munition Development Work Ongoing
- Lethal Payload Size
- Low Gun Loads
- Lighter Ammunition

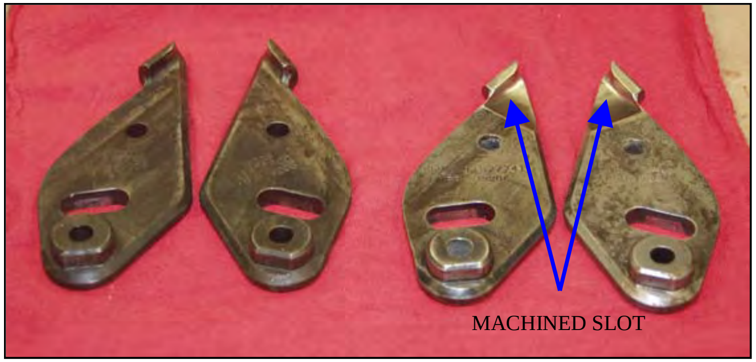
120mm DIAMETER MUNITION OFFERS BEST OPTIONS

M102 Howitzer 120mm Conversion Demo

- Fire Baseline 105mm M1 Howitzer Rounds and 120mm M931 Mortar Rounds from Modified M102 Howitzer
- Verify Functionality of 120mm Breech Loaded Mortar Concept, Establish Baseline Launcher for Unguided, Guided, and UAV Munitions
- Blast Overpressure Comparison
  - Reduce Blast Pressure on Aircraft Surfaces
- Recoil Force Comparison
  - Reduce Load on Aircraft
- 120mm Characterization
  - Range
  - Initial Flight Stability
  - Interior Ballistics

M102 Howitzer 120mm Conversion Demo

- Bore Barrel ID to 4.732 inches (120.2mm)
- Breech Ring - Machine Larger Radius
- Breech Block - Machine Larger Radius
- Extractors - Machine Pockets To Fit 120mm Case



M102 Howitzer 120mm Conversion Demo

- **Flight Stability of Mortar Round is Satisfactory**
- **Further Testing Recommended in Simulated Crosswind**

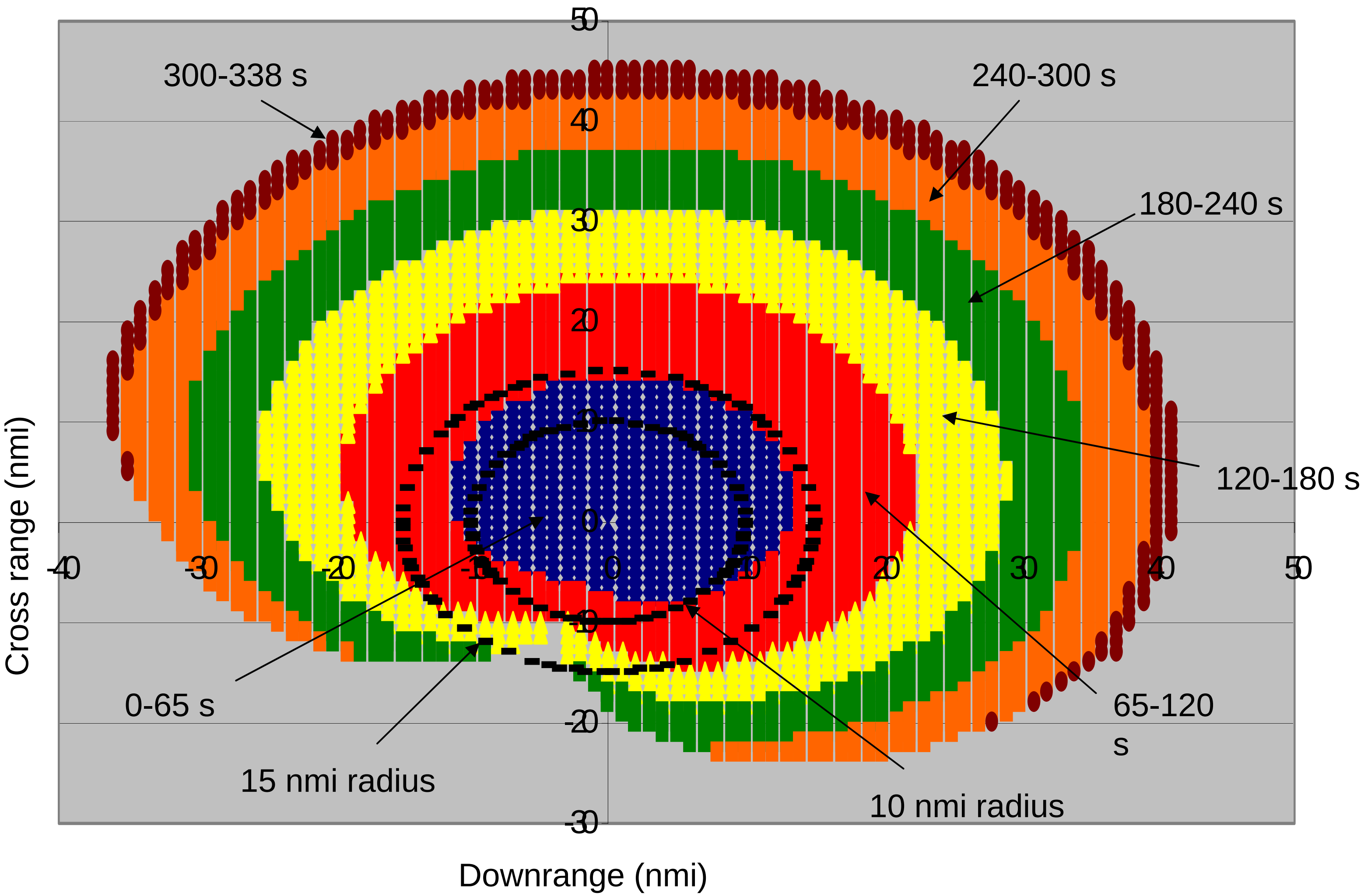
VSM Configuration Trade Studies
Range Studies

- Purpose: Investigate in Detail the Performance of the VSM with 1100 fps Initial Launch Velocity
- 1100 fps found to be best velocity for weight, length of munition
- Look at Range Achieved for Various Flight Times Using Three Launch Methods:
  - Side
  - Top
  - Forward
- Expand Study to Include Lighter Munition (15 pound Warhead vs. 20 Pound Warhead) Capable of Meeting 15 nmi/65 second Requirement
- Investigate Low Level CONOPS and Ground Launch Range of Munitions

VSM Configuration Trade Studies
Range Studies

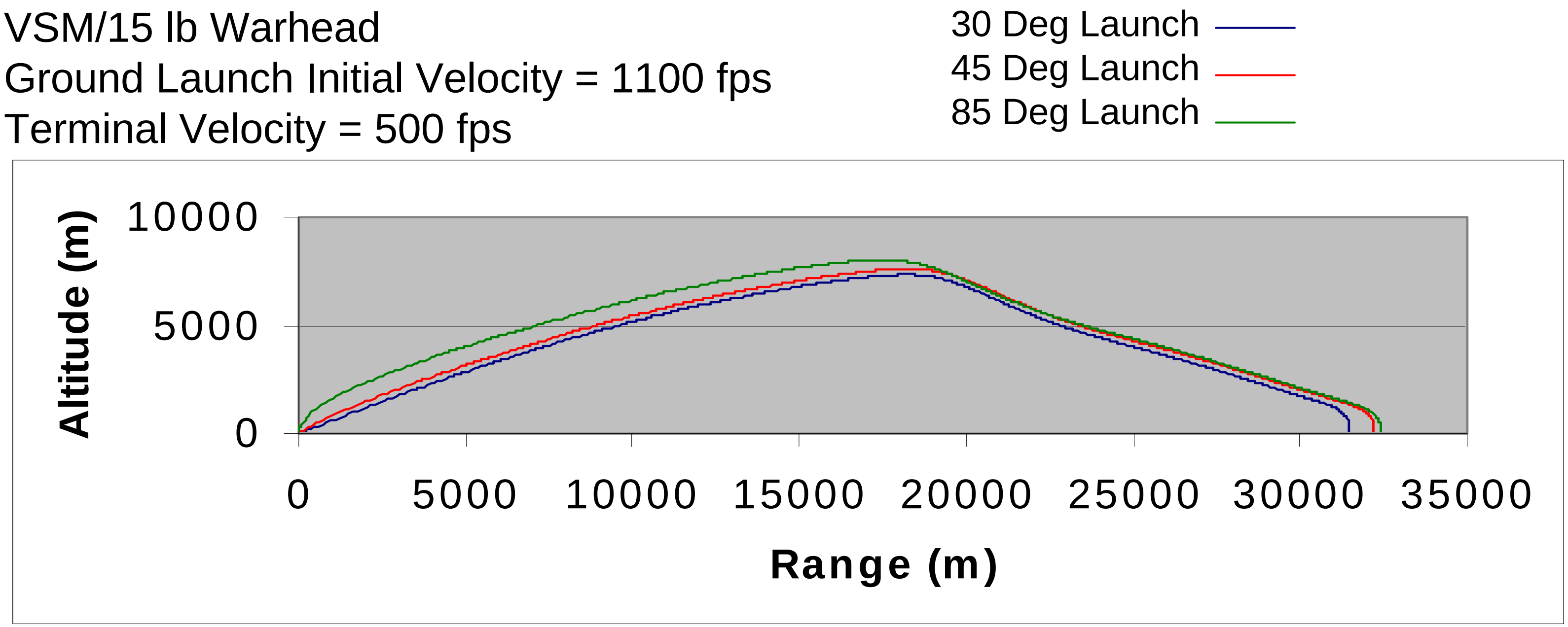
Configuration 2

Side Launched
Initial Velocity = 1100 fps
AOF = -90 deg

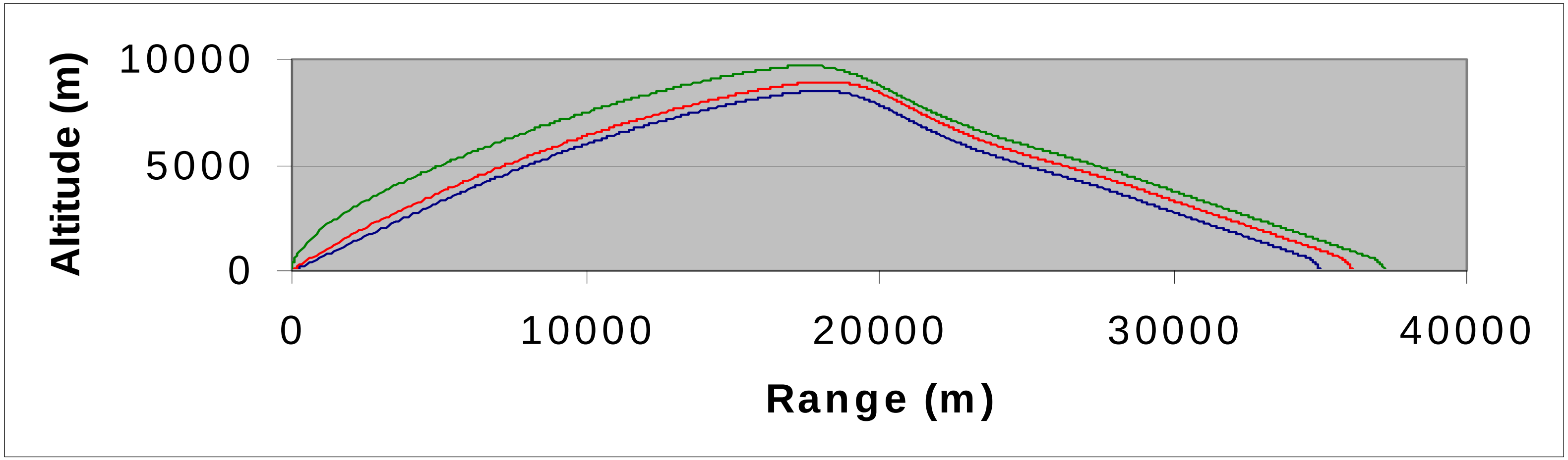


VSM Configuration Trade Studies
Range Studies

VSM/15 lb Warhead
Ground Launch Initial Velocity = 1100 fps
Terminal Velocity = 500 fps



-90 Deg Angle of Fall

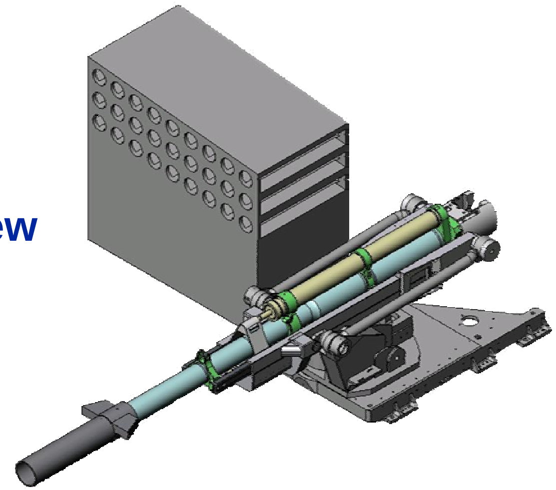


-70 Deg Angle of Fall

AC-130 Spiral Launcher Approach

120mm Breech Loaded Cannon Launching System

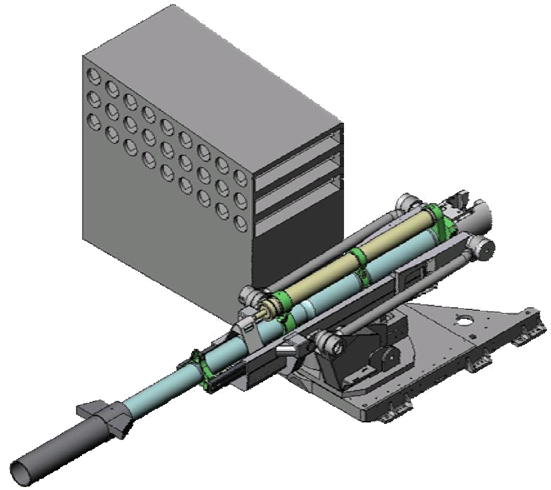
- **120mm Launcher/Munition interface**
  - **Lightweight Launcher and Ammunition**
  - **Lower Recoil Loads and Blast Overpressure**
  - **Safe Reliable Munition Separation**
  - **Multiple Service User Base**
- **Retains AC-130 Like Capabilities as Well as Embracing New Capabilities**
  - **Pylon Turn Not Necessary for Fire Control**
  - **CoPac Develops Instantaneously Computed Solution**
- **Multiuse**
  - **Conventional Unguided Ammunition**
  - **One or Two DOF Guidance as Well as Fully Maneuvering Munitions**
  - **Soft and Hard Launch of Munitions**
- **Automated Handling and Loading System**
  - **Tightly Integrated with CoPAC**
  - **Providing Health and Status of Ammunition and Launcher**

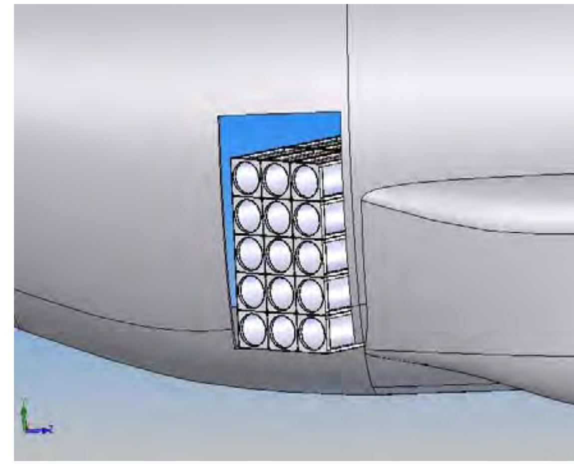


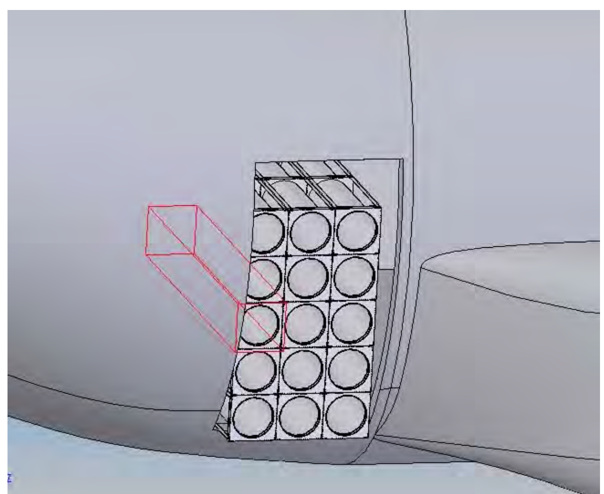
PSAS Launcher

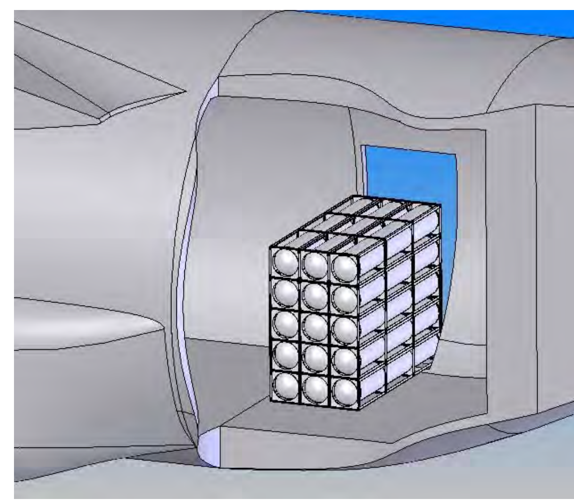
PSAS Launcher Concepts:

- **Must address LO Platform Requirements**
- **Autoloaded Trainable Gun Launcher**
- **Fixed Tube Bank Launcher**
- **VSM works in either type**

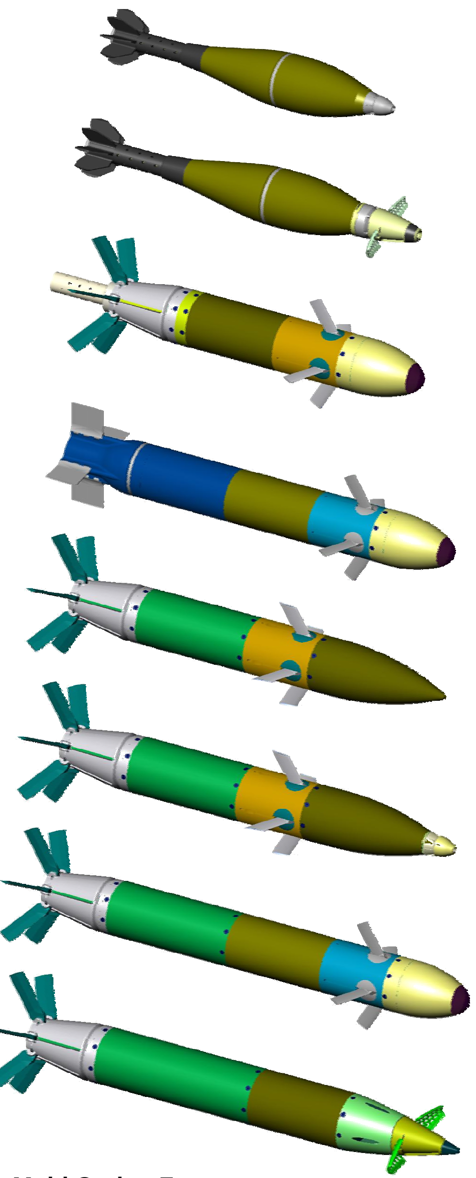




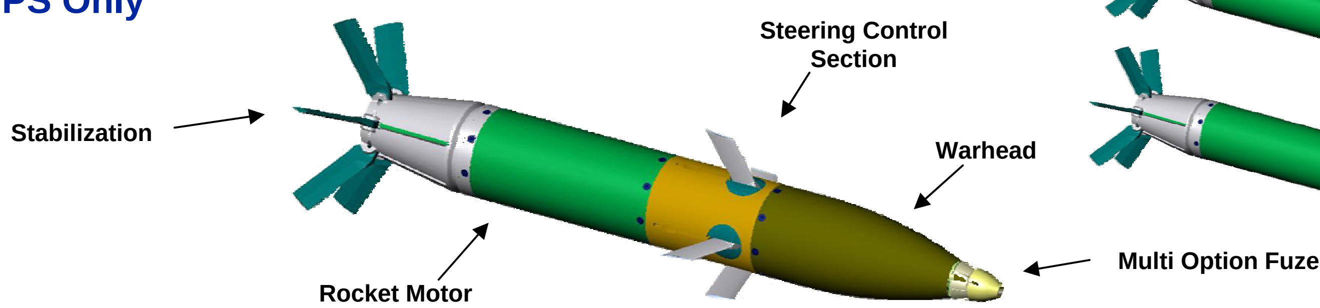




Munition Approach



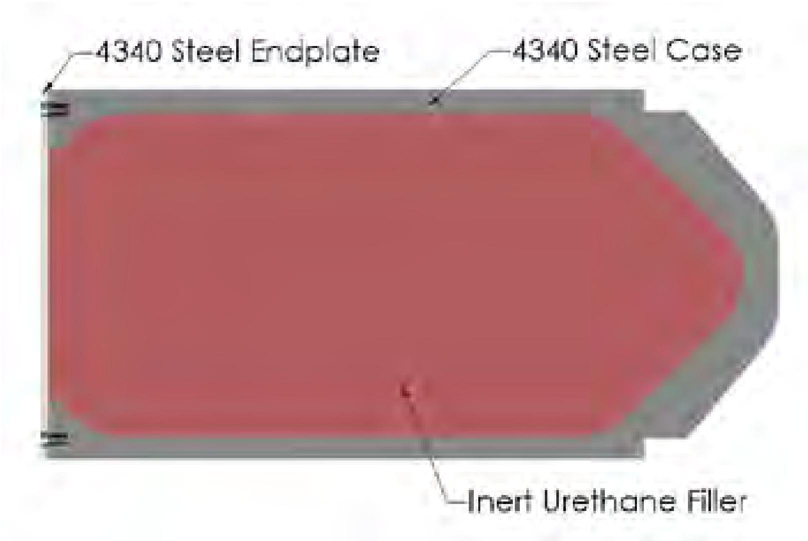
- **Modular Open System Design**
- **Member of a family of munitions**
- **Lightweight**
- **Multiple Warhead Types**
  - **Blast Frag Penetrator**
  - **EFP**
  - **Combination Blast/Frag-EFP**
  - **High Pressure Low Blast Radius Warhead**
  - **Less-than-Lethal**
- **Remote Data Control Interface**
- **GPS/INS Guidance**
- **Terminal Guidance Technologies Available**
  - **Semi Active Laser Seeker**
  - **GPS Only**



Modular Munition Design and Standard Interfaces Allows Affordability

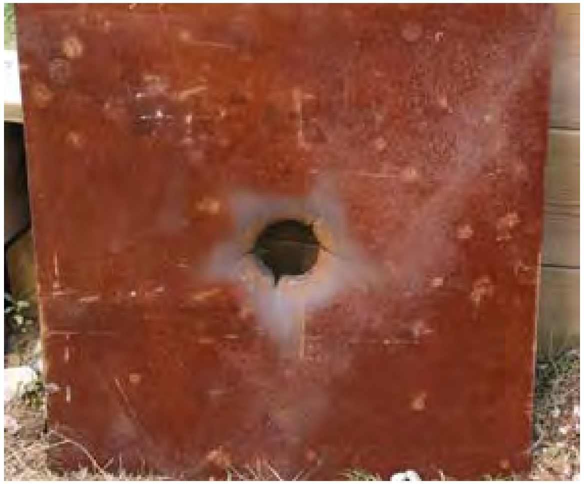
120mm Warhead Penetration Demo

- **5 Shot Series from Airgun**
- **VSM Warhead Design**
  - Inert
  - 4340 Steel Case
  - 20 pound
  - 120mm diameter
- **900 fps Impact Velocity**
- **Targets:**
  - 10.5 5000 psi Reinforced Concrete; Normal Impact
  - 7 inch 5000 psi Reinforced Concrete; 30° Obliquity
  - .5 inch RHA; Normal Impact
  - .5 inch RHA; 30° Obliquity
  - 1 inch RHA; Normal Impact



120mm Warhead Penetration Demo

Target Material	Target Thickness, in.	Obliquity, degrees	Impact Vel, ft/s	Complete Perforation	Exit Vel, ft/s	Projectile Assembly Weight, lb
RHA Steel	1	0	892	No	n/a	22.30
RHA Steel	0.5	0	888	Yes	556	21.80
RHA Steel	0.5	30	896	Yes	655	22.01



Penetration Hole in 0.5-in. RHA Steel

Bulge in 1-in. RHA Steel Plate, Exit View

Target Damage, Shot PGM-S03 .5” RHA 30° Obliquity

120mm Warhead Penetration Demo

Target Material	Target Thickness, in.	Obliquity, degrees	Impact Vel, ft/s	Complete Perforation	Exit Vel, ft/s	Projectile Assembly Weight, lb
Concrete	10.5	0	910	Yes	194	22.54
Concrete	7	45	914	Yes	242	22.27

Entrance Hole, Test PGM-C01
10.5” 5K RC

Exit Hole, Test PGM-C02
7” 5K RC 30° obliquity

120mm Warhead Penetration Demo

7 inches 5000 psi Reinforced Concrete
45° Obliquity

Summary

Very Small Munition:

- **120mm Diameter**
- **Launchers:**
  - **side firing gun capable of firing standard 120mm mortar ammunition**
  - **PSAS Concept Launcher**
- **Provides 360° Coverage from either AC-130 or PSAS**
- **A Viable Spiral for AC-130**
- **Meets PSAS Roadmap Objectives**

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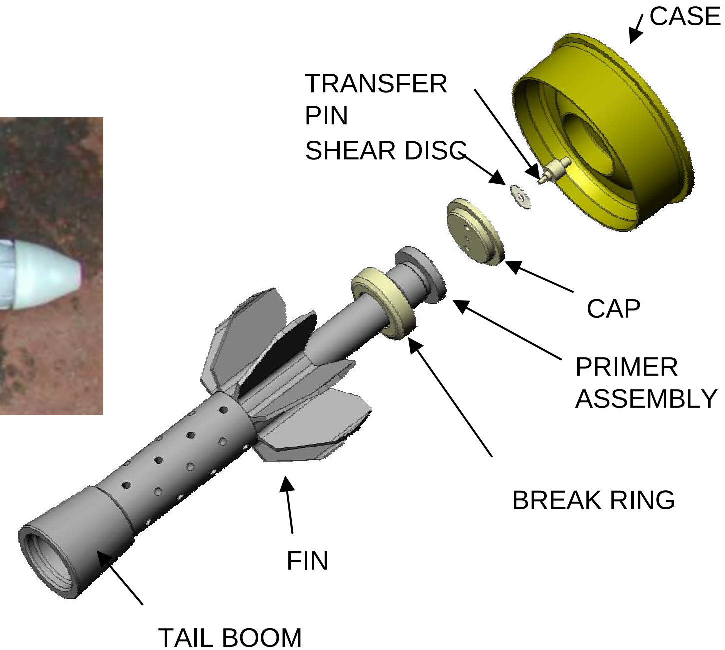
BACKUPS

M102 Howitzer 120mm Conversion Demo



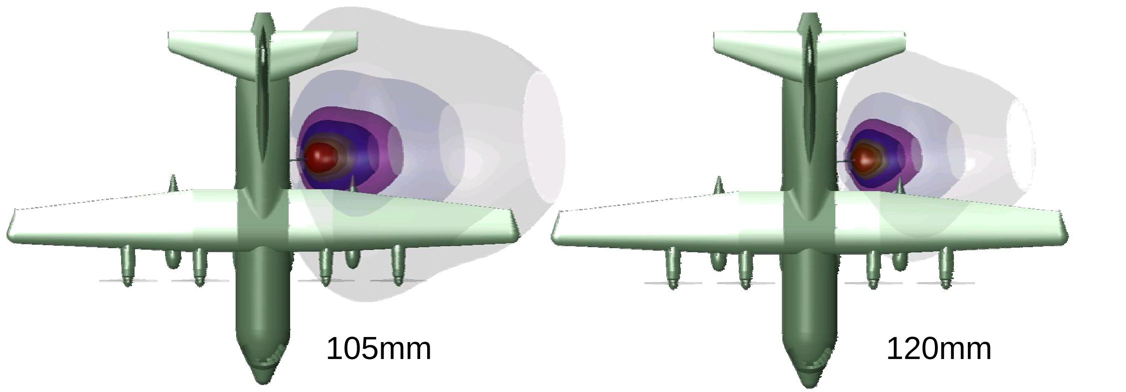
- **Standard M931 TP Cartridge**

- **M931 After Conversion**
- **Conversion Applicable to All M930 Series Ammunition**

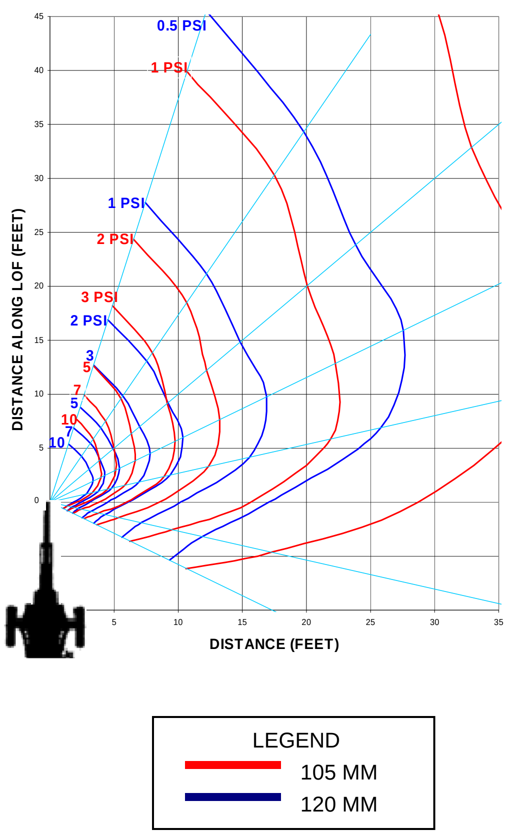
M102 Howitzer 120mm Conversion Demo

- **Blast Overpressure of 120mm was Approximately 35% Lower than 105mm**
- **120mm Mortar Rounds Shot at Highest Charge**
  - **Further Reduction in Blast Possible from Lower Propellant Charge Configuration**

Overlay of 3D Blast Pressure Curves on C-130

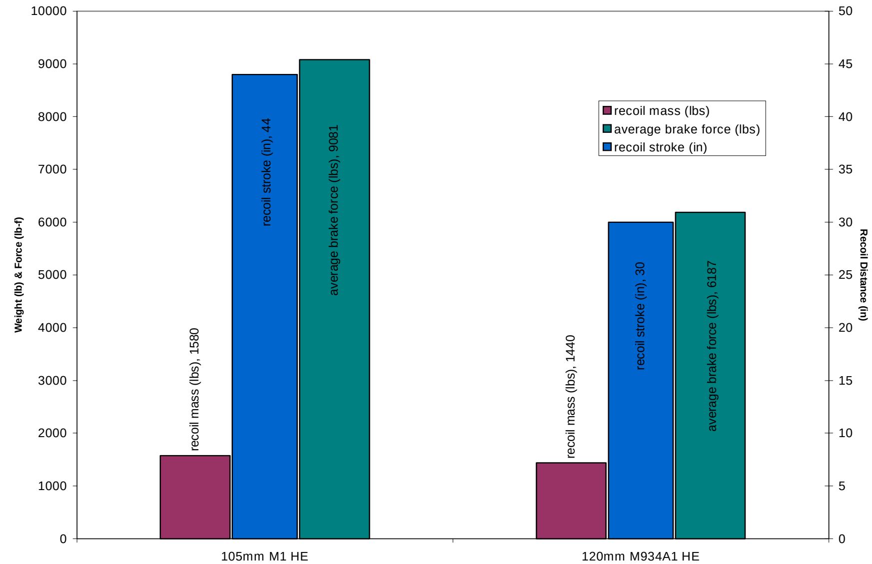


Blast Pressure Curves



M102 Howitzer 120mm Conversion Demo

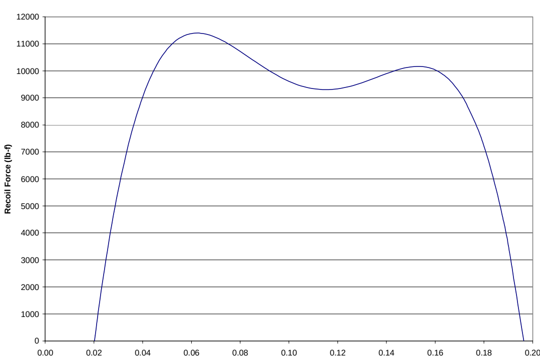
- **Recoil Force of 120mm was Approximately 30% Lower than 105mm**
- **Recoil Mechanism Can be Optimized for 120mm Gun**
  - **Further Reduction in Recoil Force**
  - **Lighter Weight Gun Components**
- **Lower Charge Propellant Should Reduce Recoil Loads**



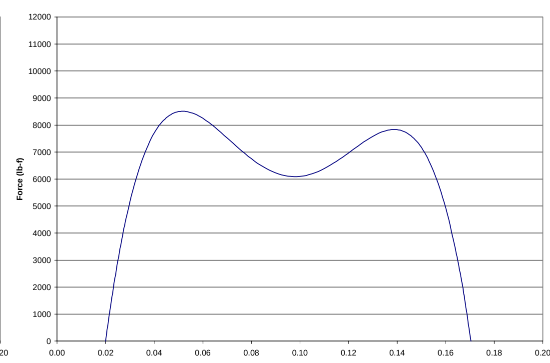
105mm 120mm

LEGEND	
Recoil mass	
Recoil stroke	
Avg. recoil force	

Recoil force curves from high speed video derivation, force vs. time



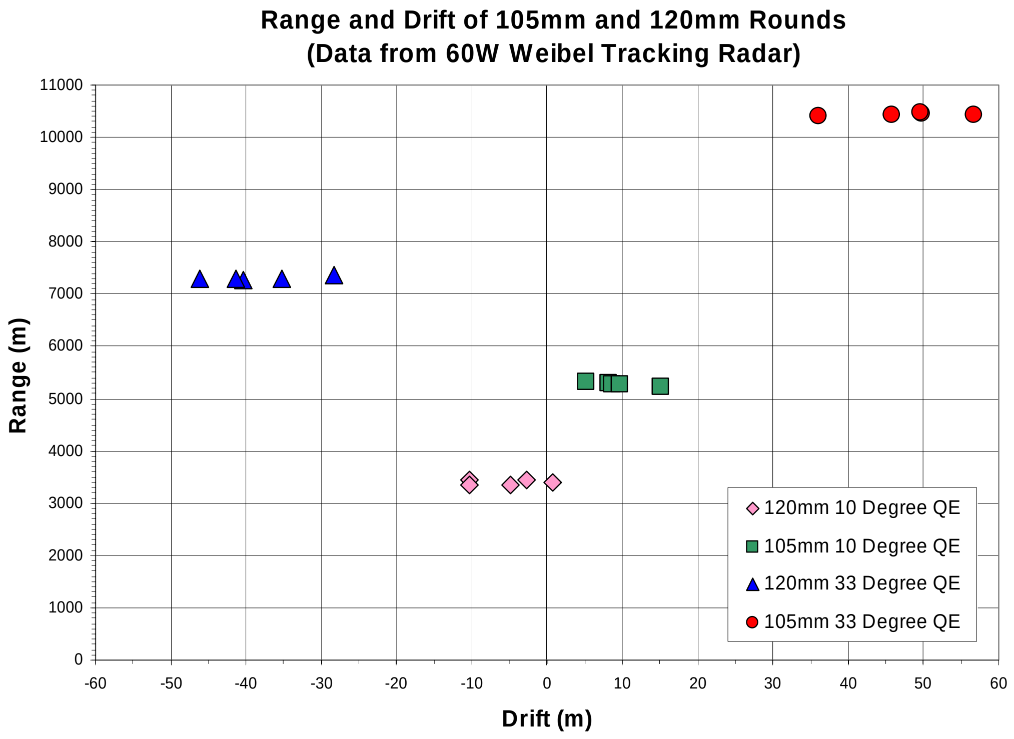
105mm



120mm

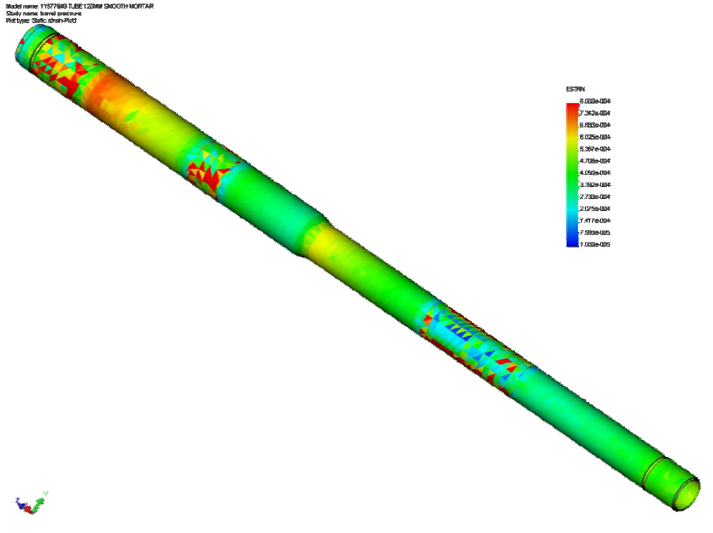
M102 Howitzer 120mm Conversion Demo

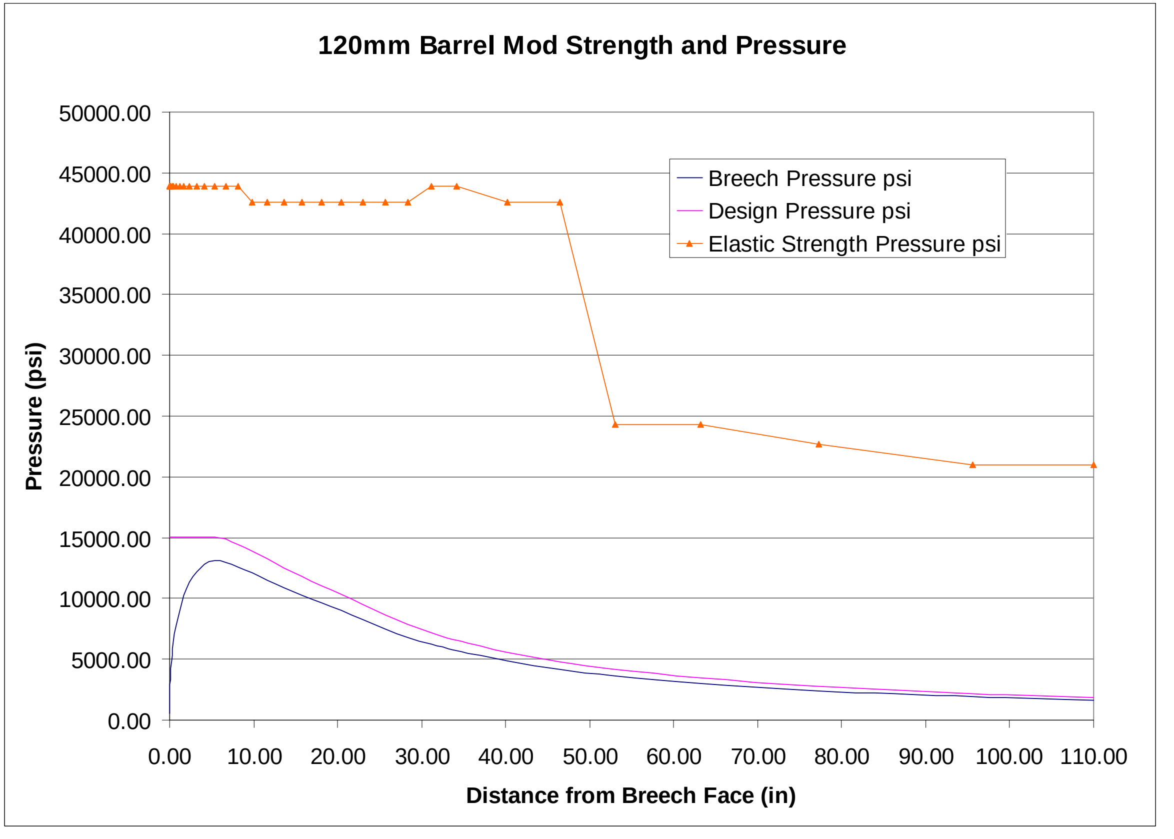
- **120mm Muzzle Velocity -> 1218 ft/s**
  - **Maximum Muzzle Velocity from M120 Mortar -> 1040 ft/s**
- **120mm Range: 10° QE -> 3400 m Average; 33° QE -> 7300 m Average**
  - **Maximum Predicted Range for 120mm -> 8100 m**
  - **Maximum Range from M120 Mortar ->7270 m**



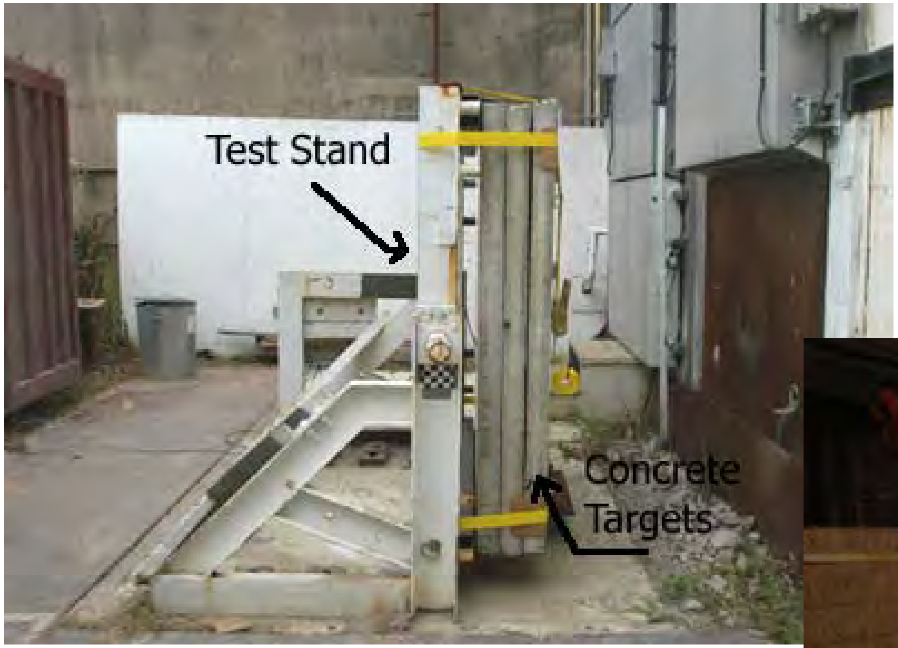
M102 Howitzer 120mm Conversion Demo

- Design Pressure of Gun System Below Elastic Strength Pressure
  - Optimize Gun Dimensions to Reduce Weight and Footprint
  - Optimize Recoil Mechanism to Reduce Recoil Load

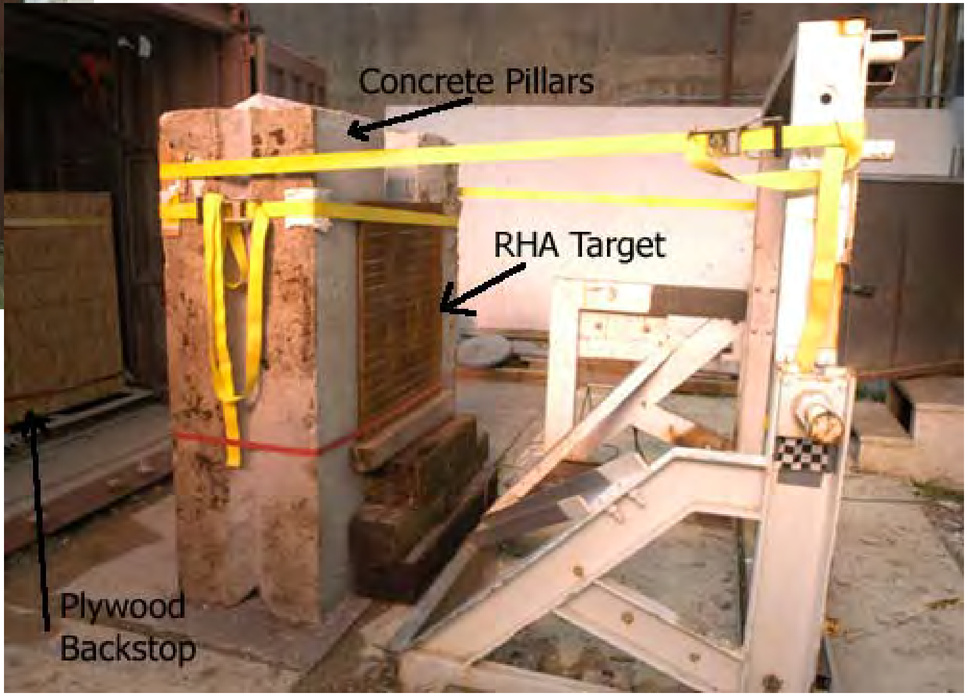




120mm Warhead Penetration Demo

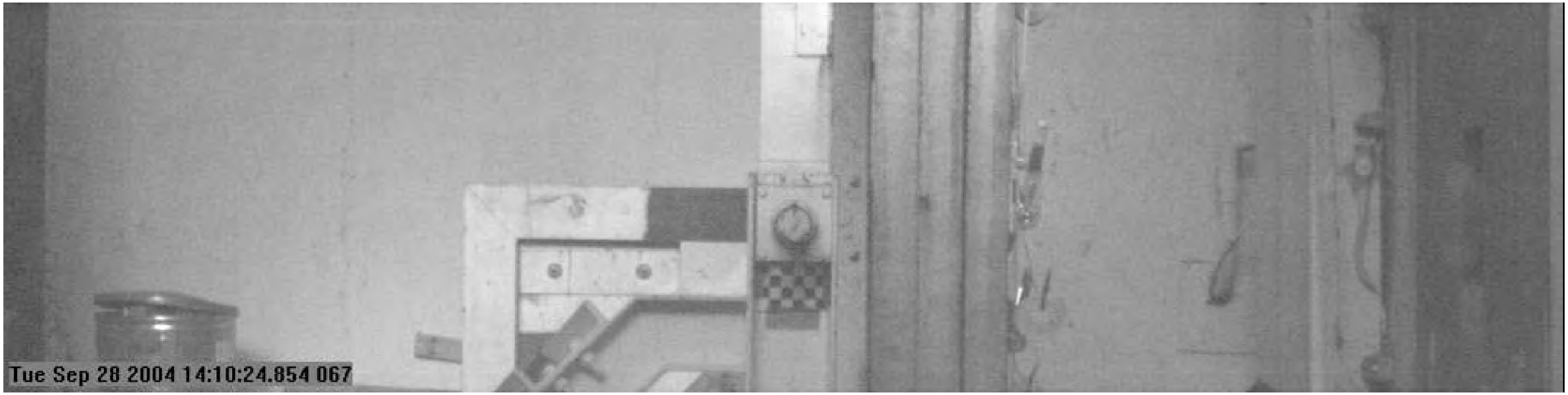


Concrete Target and Oblique RHA Test Setup



Normal Impact RHA Steel Target Setup

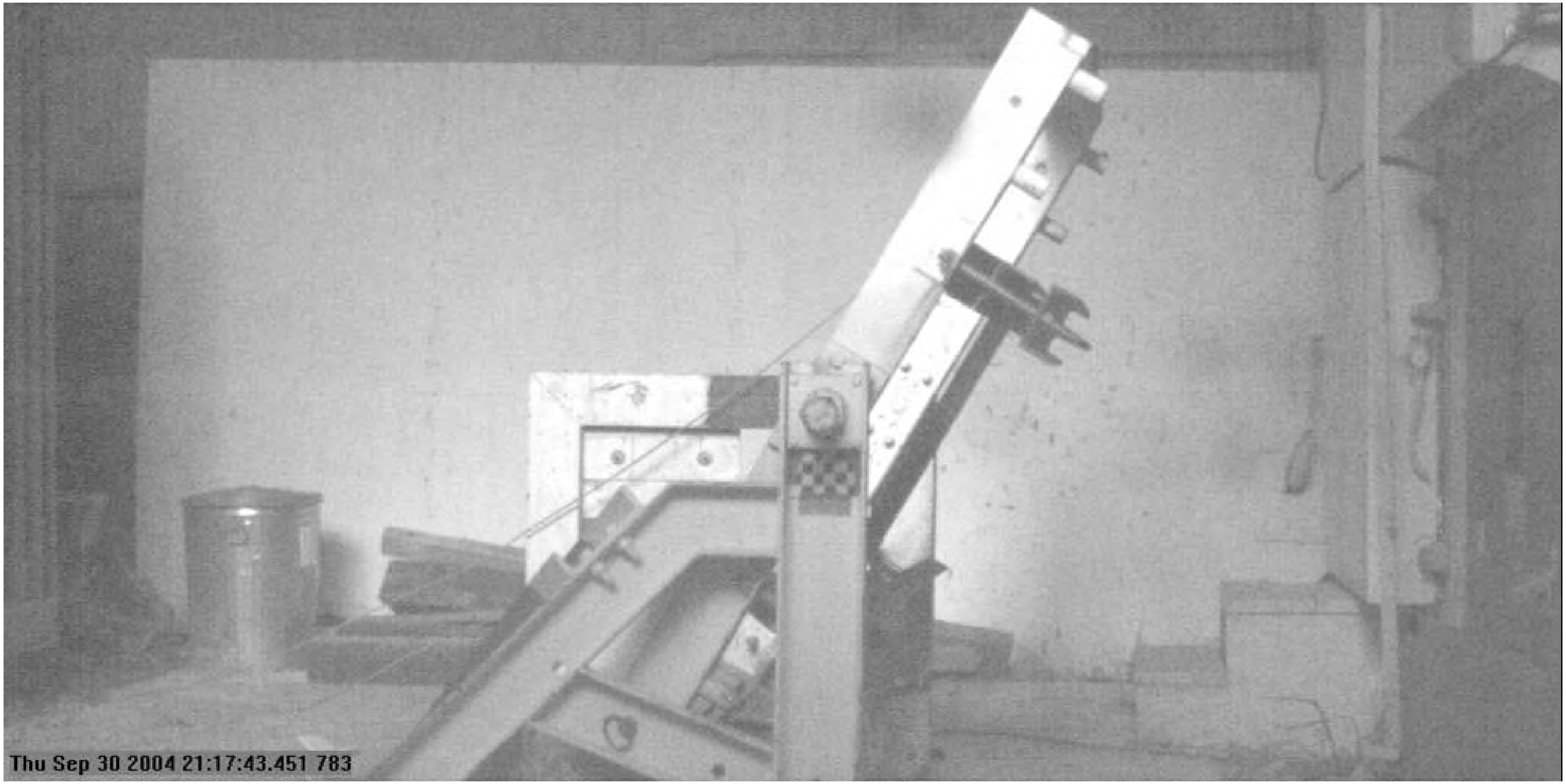
120mm Warhead Penetration Demo



10.5 inches 5000 psi Reinforced Concrete

0° Obliquity

120mm Warhead Penetration Demo

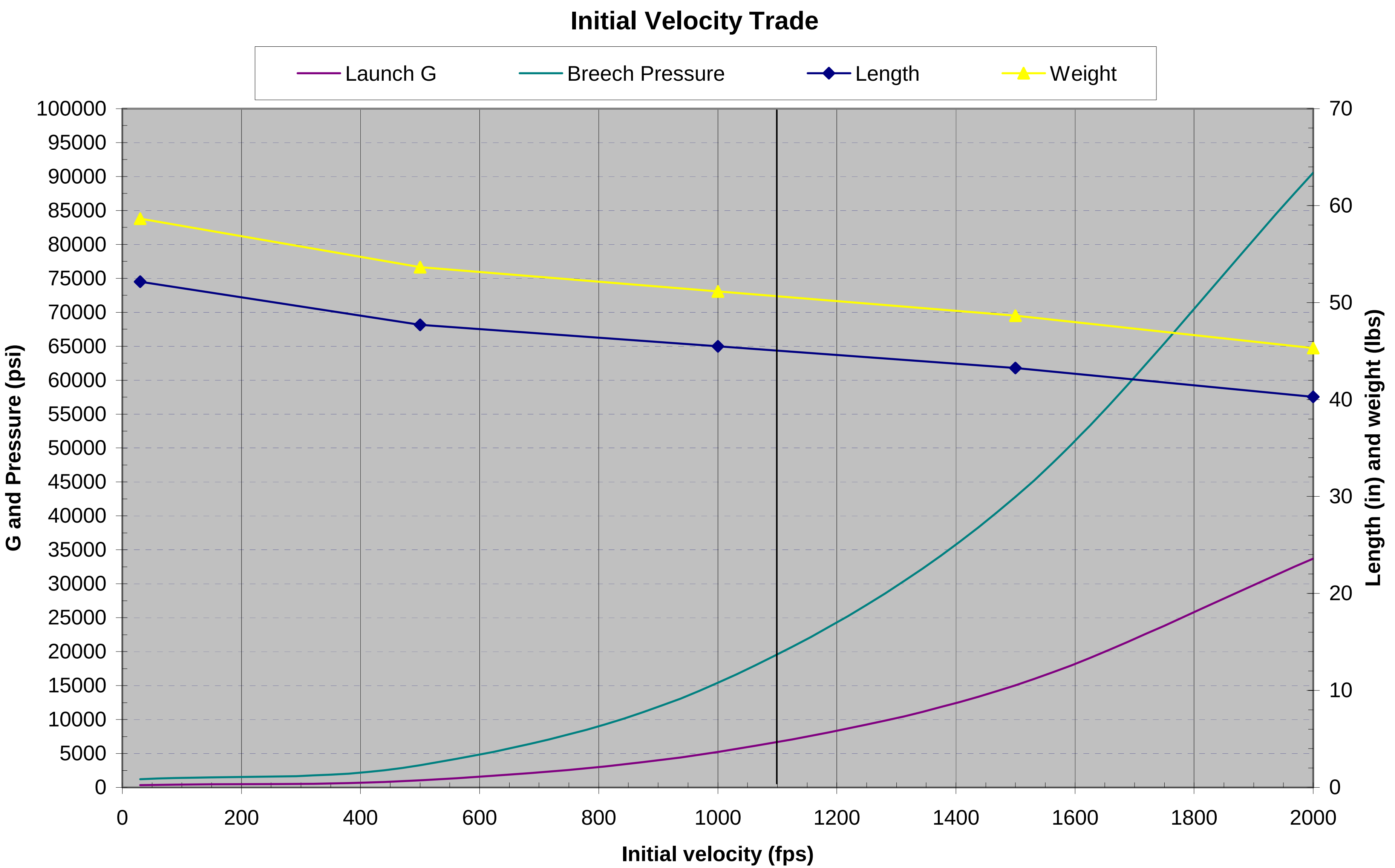


.5 inches RHA
30° Obliquity

VSM Configuration Trade Studies Initial Velocity

- **Purpose: Investigate Length and Weight Payoff of Utilizing Higher Gun Launch Initial Velocity vs. Carrying More Rocket Propellant in Munition.**
- **Fixed Performance: Munition to Achieve 15 nmi in 65 seconds**
- **Allow Necessary Weight and Length to Vary Given Different Initial Velocities**
- **Considerations:**
  - **G Load on Munition**
  - **Recoil Loads**
  - **Chamber Pressure**
  - **Munition Length**
  - **Munition Weight**

VSM Configuration Trade Studies
Initial Velocity



VSM Configuration Trade Studies
Initial Velocity

- Higher Initial Velocity Allows Munition to Loose Weight and Length for Same Given Range Performance
- Limiting Factors
  - Chamber Pressure
  - G Loads on Munition – 7500 G is not Difficult for Mortar Ammunition Components
- 1100 fps Yields Acceptable Levels for All These Parameters:
  - 51-pound Munition
  - 45 inches Long
  - 21,000-psi Chamber Pressure
  - 7200 G
- Lower Mortar Propellant Increments will Permit Lower G Launch, and Munition Weight and Length Benefits will be Achieved, Needs Further Investigation

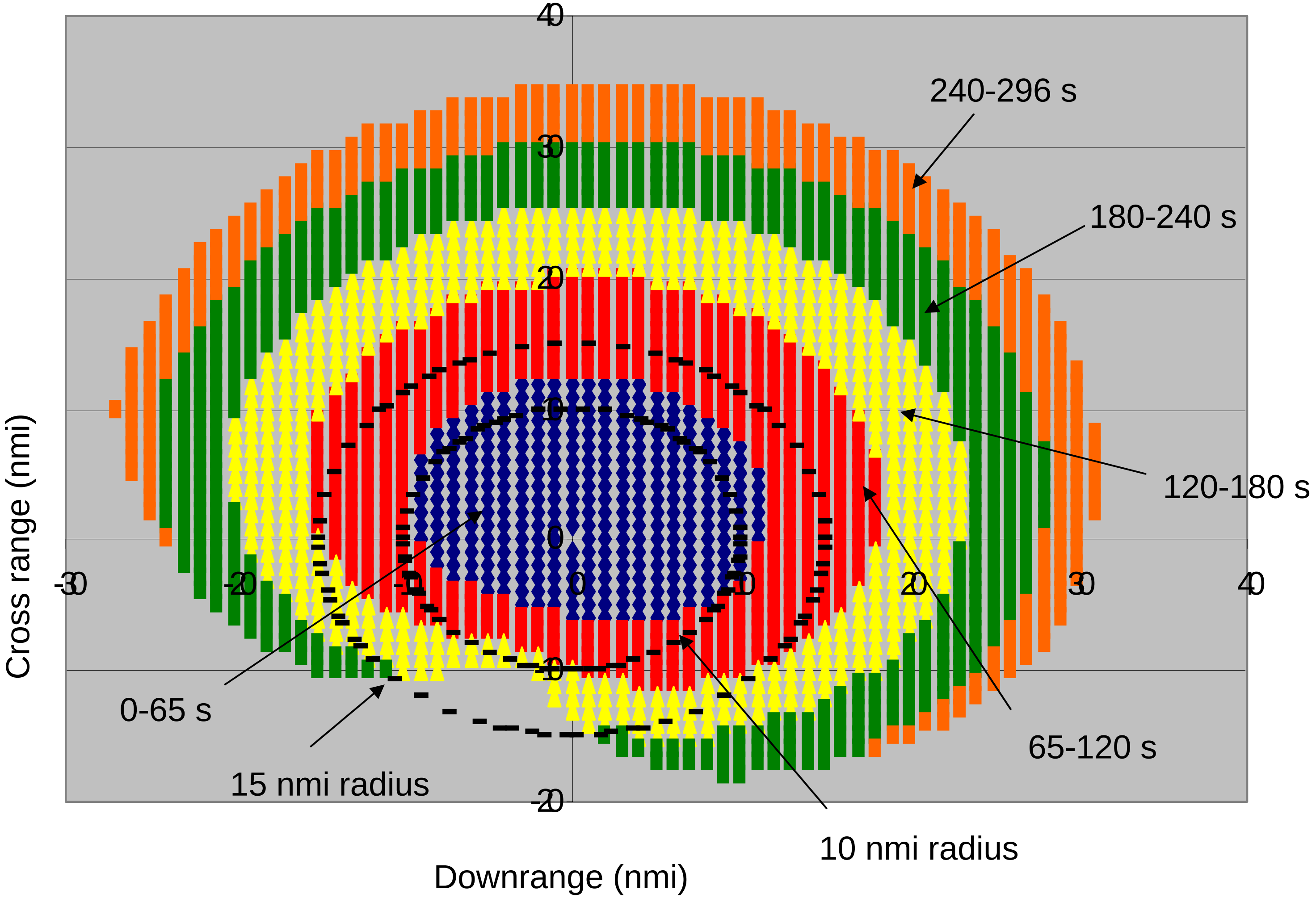
VSM Configuration Trade Studies
Range Studies

- **Side Launching Munitions Offers Some Performance Advantages Over Top and Forward Launch**
- **Top Launch has Best Extended Range Advantage, but has Some Difficulty Getting Under AC**
- **New Control Algorithms Being Examined for Better Offside Performance from Side Launched Munitions**
- **Low Altitude CONOPS are Feasible with this Munition**
- **VSM would have Tremendous Application as a Ground Combat Fire Support Munition**
- **The Range and Response Time Requirements must be Examined in the Context of the Overall PSAS Combat System**

VSM Configuration Trade Studies
Range Studies

Configuration 1

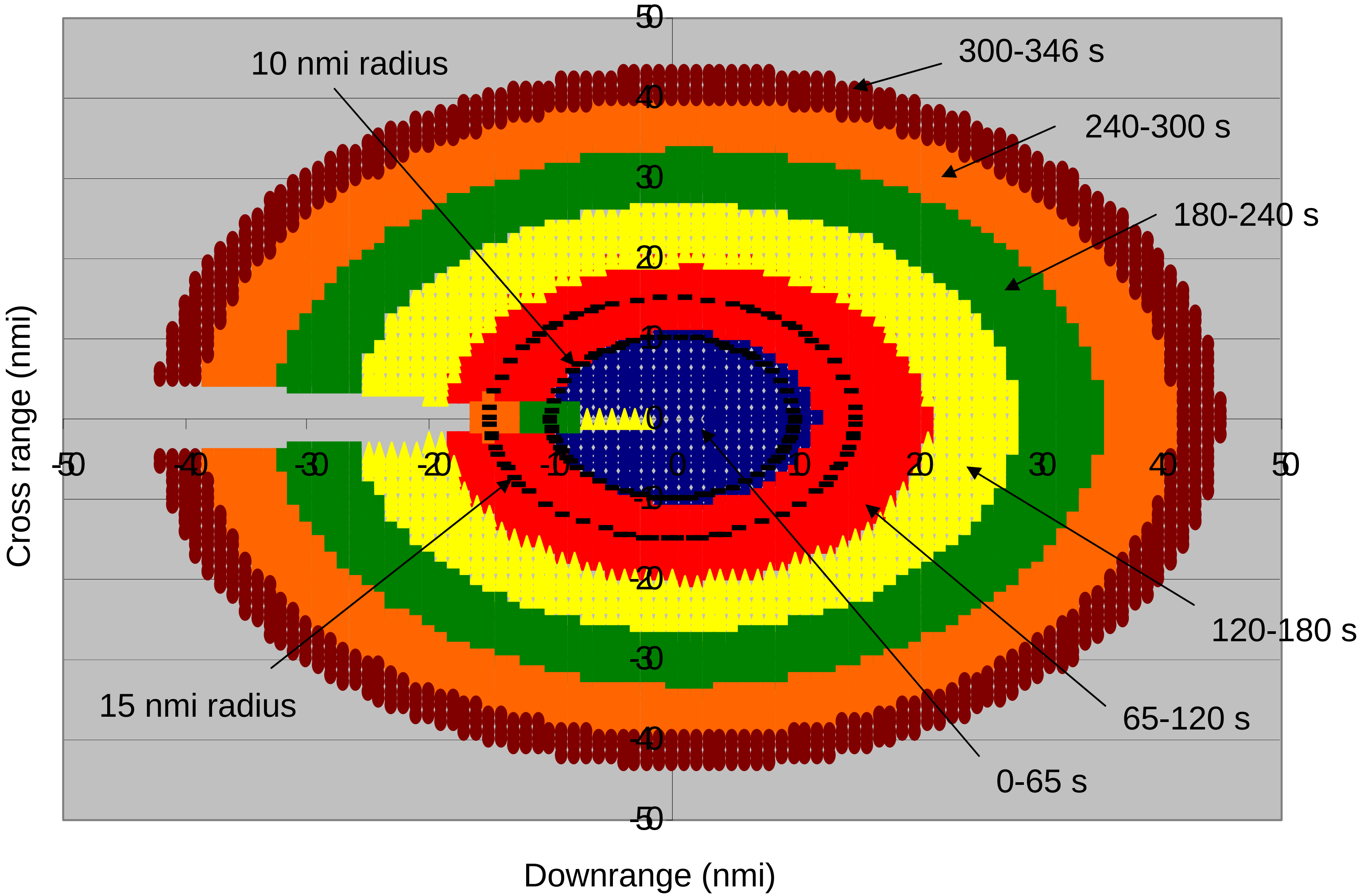
Side Launched
Initial Velocity = 1100 fps
AOF = -90 deg



VSM Configuration Trade Studies
Range Studies

Configuration 1

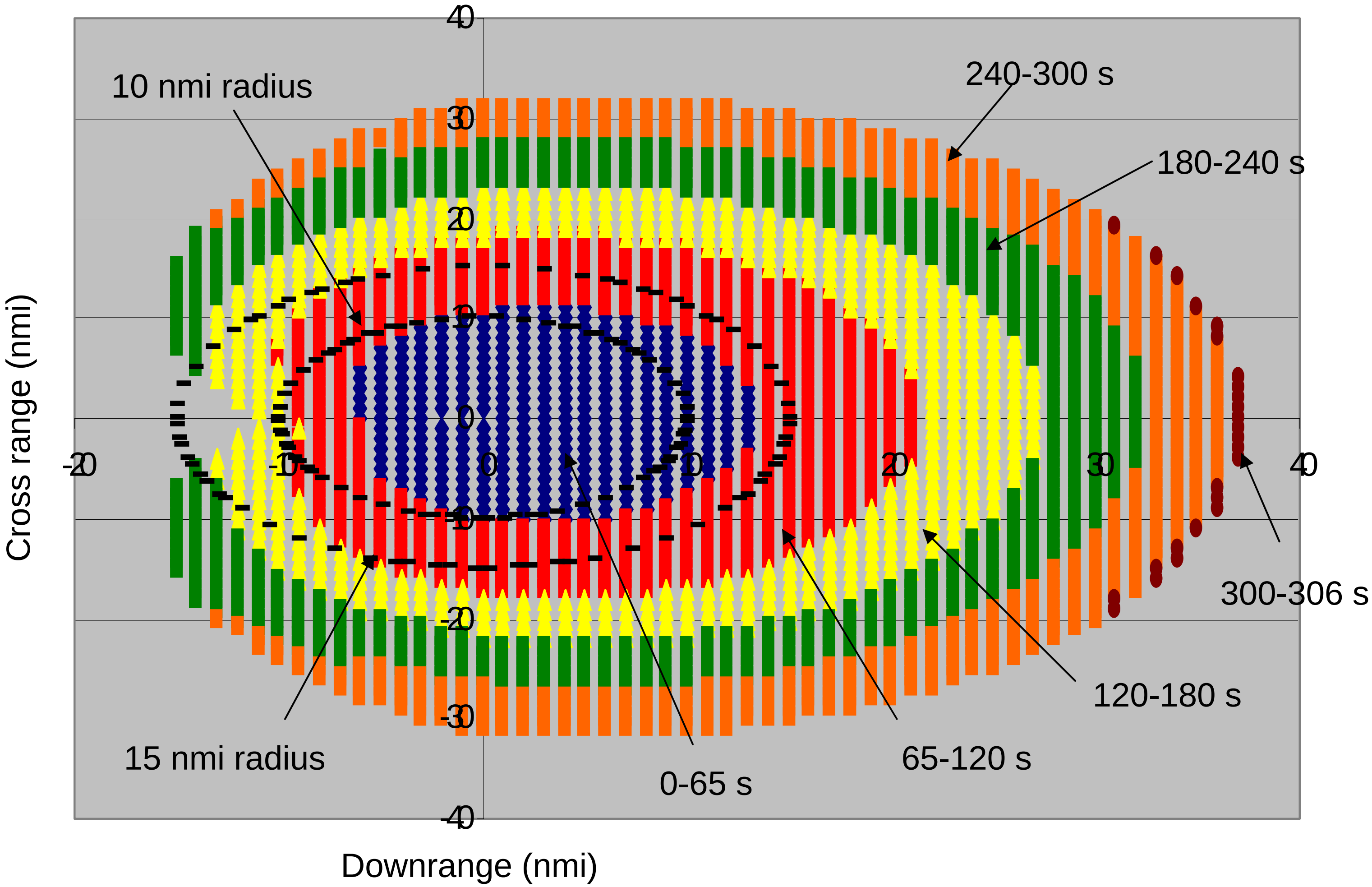
Top Launched
Initial Velocity = 1100 fps
AOF = -90 deg



VSM Configuration Trade Studies
Range Studies

Configuration 1

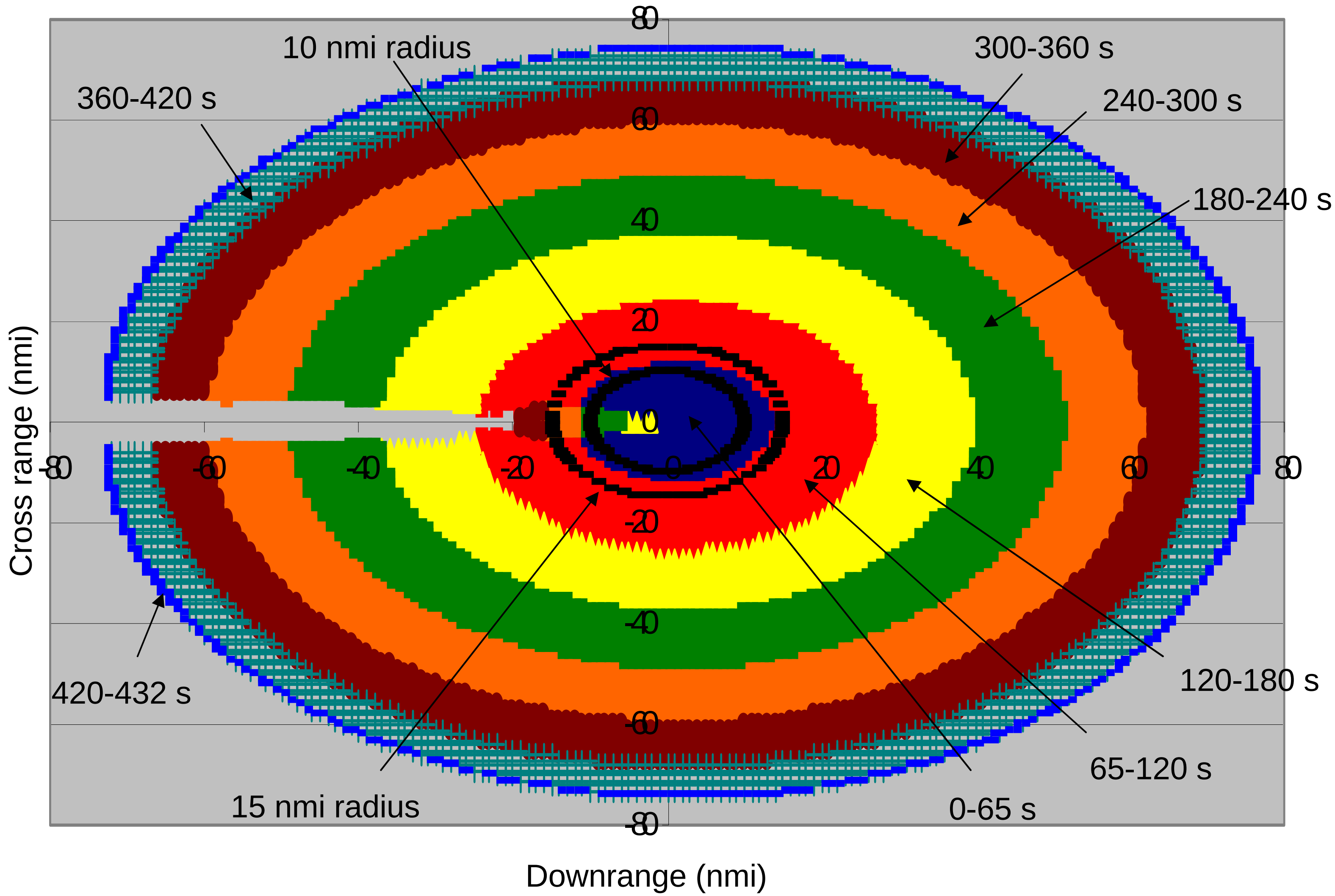
Forward Launched
Initial Velocity = 1100 fps
AOF = -90 deg



VSM Configuration Trade Studies
Range Studies

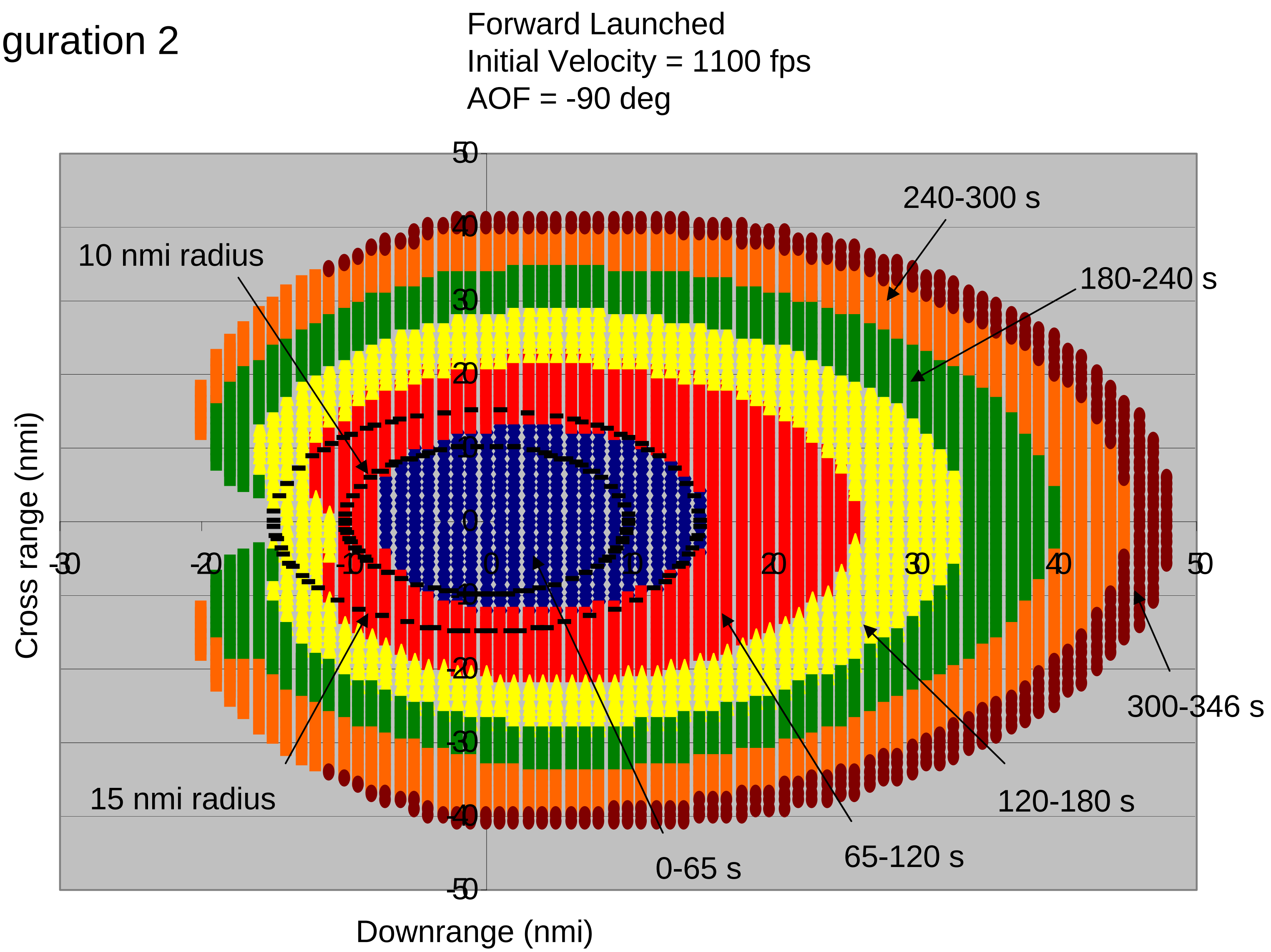
Top Launched
Initial Velocity = 1100 fps
AOF = -90 deg

Configuration 2



VSM Configuration Trade Studies
Range Studies

Configuration 2



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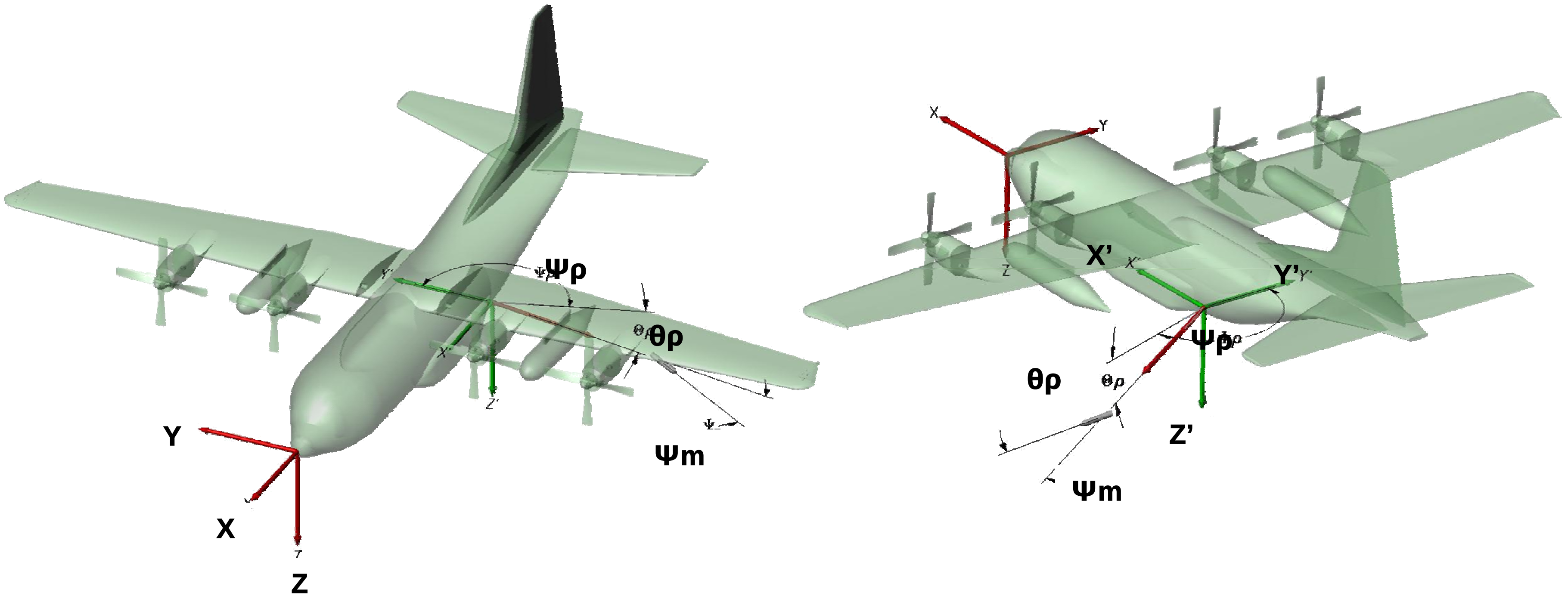
VSM Configuration Trade Studies
Munition / Aircraft Separation Study

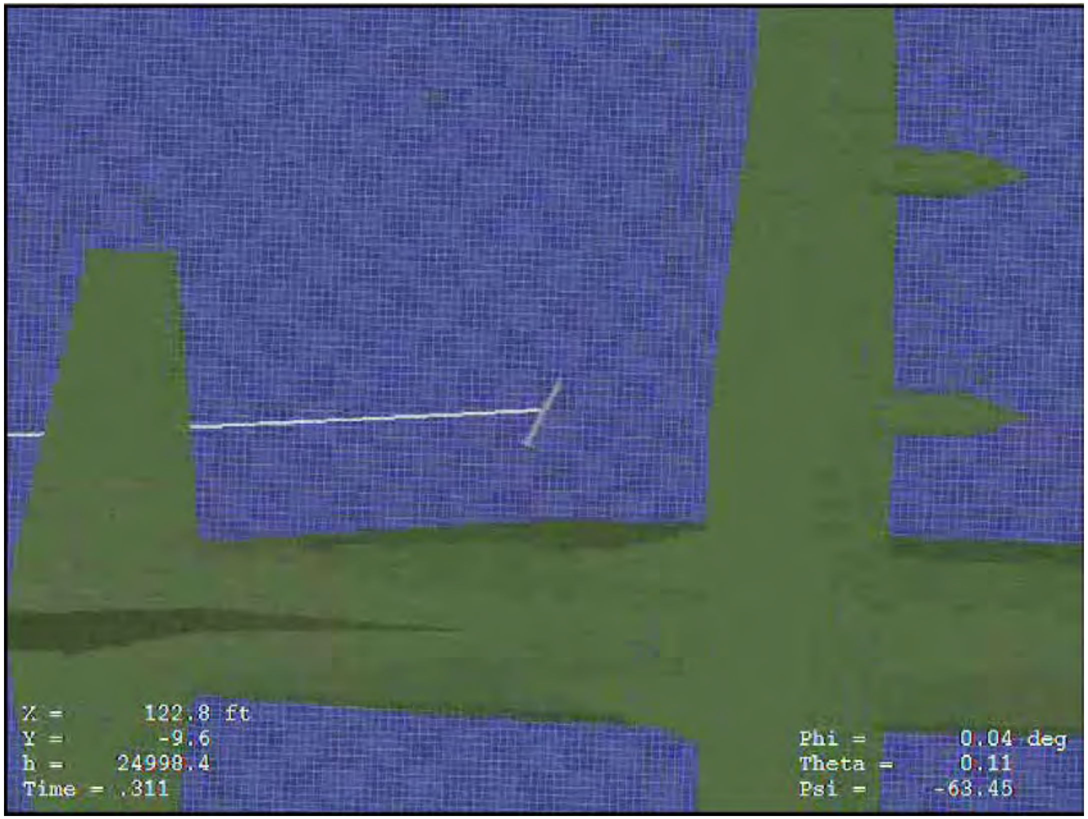
- **Purpose of Study: Develop a Simulation that will Allow Modeling of Munition Flyout from AC**
- **Six Degree of Freedom (6-DOF) Simulation**
- **Ejection Speed (Study Variable)**
- **Parameters:**
  - **C-130 Slip Stream and Prop Wash is Modeled**
  - **Munition is Unguided Through Separation**
  - **Munition Initial Conditions Based Upon:**
  - **Aircraft Velocity (240 kts)**
  - **Launcher Position Relative to Aircraft (X', Y', Z')**
  - **Two Launcher Angles Relative to Aircraft: Azimuth Ψ_p, Elevation θ_p**
  - **One Munition Angle Relative to Launcher: Azimuth Ψ_m**

VSM Configuration Trade Studies
Munition / Aircraft Separation Study



Global (Aircraft): X, Y, Z
Local (Launcher): X', Y', Z'
Launcher Azimuth: Ψρ
Launcher Elevation: θρ
Munition Azimuth: Ψm

VSM Configuration Trade Studies
Munition / Aircraft Separation Study



- Initial Velocity: 100 fps
- Initial Velocity: 250 fps.
- Initial Velocity: 30 fps Good Trajectory
- Initial Velocity: 30 fps Bad trajectory

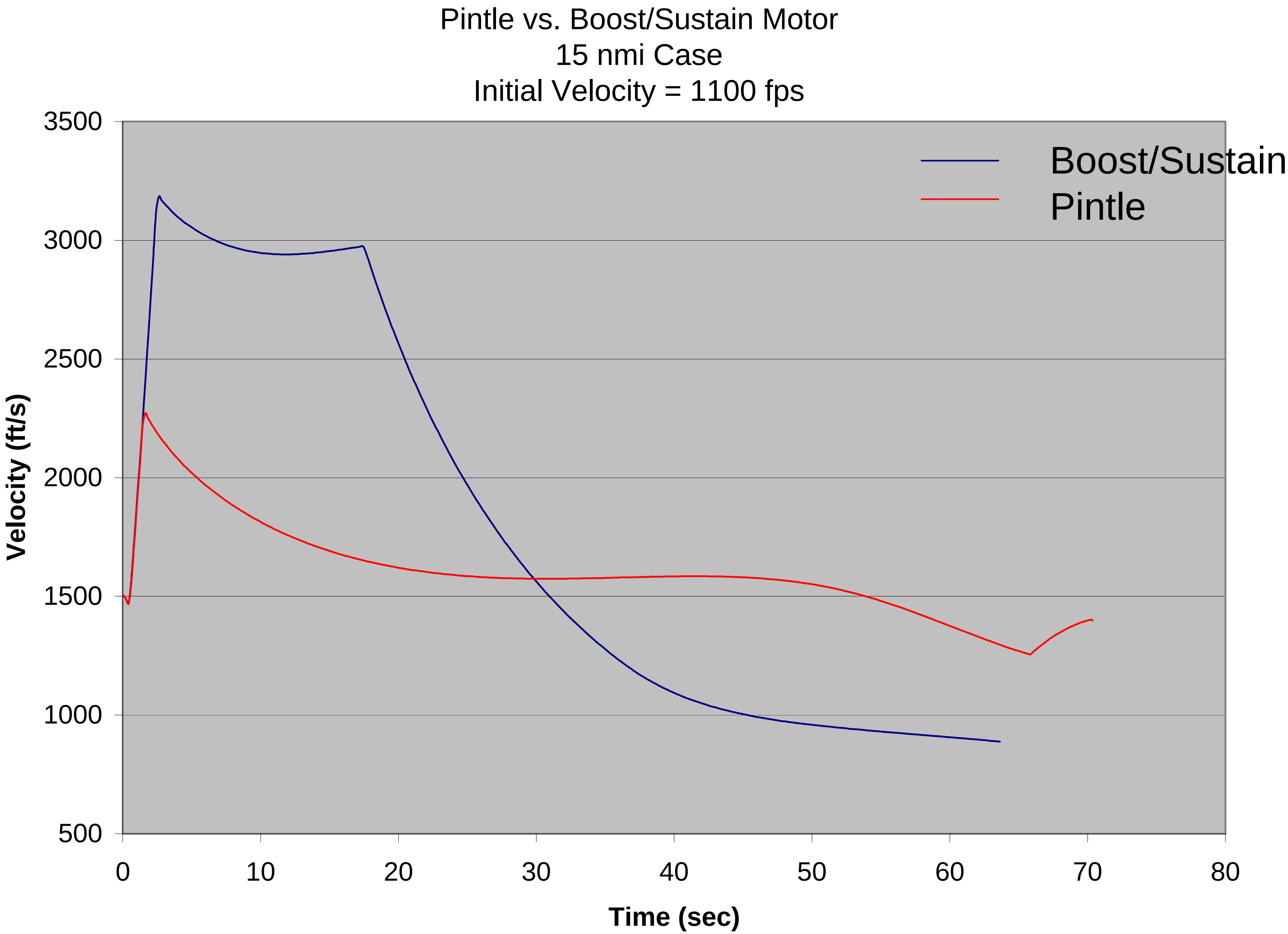
VSM Configuration Trade Studies Munition / Aircraft Separation Study

- **Initial Studies of Munitions Indicates that Lower Launch Velocities (200-500) will not have Difficulty Separating from AC**
- **Oscillation of Munition During Low Velocity Launch May be an Issue for Guidance System**
- **Further Development of Simulation Warranted Using AFSOC Owned AC-130 Flow Field Model Developed by Auburn University**
- **Results Should be Verified in Actual Flow Field**

VSM Configuration Trade Studies
Motor Configuration

- Study of Pintle Motor Configuration Examined to Investigate Potential of this Type of Motor
- Possible Pintle Motor Trade-offs:
  - Fly During "Cruise" with Low Mass Flow Rate Allowing for Possible Higher Terminal Velocities
    - This Allows for More Propellant to be Left to Throttle Up With
  - Fly During "Cruise" with High Mass Flow Rate Allowing for Possible Shorter Time-of-Flights
    - This Leaves Little Propellant for Throttling Up, but can Possibly Give Better Time-of-Flights than a Boost/Sustain Motor
- This is only a rough cut! This pintle motor design will need some optimization to determine what the best burn conditions are for the specified mission (i.e. higher terminal velocities and shorter time-of-flights may be possible to achieve).

VSM Configuration Trade Studies
Motor Configuration



VSM Configuration Trade Studies
Motor Configuration

- Rough Cut Analysis Indicates that the Configuration is Promising
- May Need to Be Soft Launched
- Less Mature Technology
- This Pintle Motor Design will Need Some Optimization to Determine What the Best Burn Conditions are for the Specified Mission
- With this Technology it may be Possible to Achieve:
  - Higher Terminal Velocities
  - Shorter Time-of-Flights

Update on Picatinny High Speed Turret

Presented to 2005 NDIA Guns and Ammunition Conference
New Orleans, LA
25-28 April 2005

Richard A. Ciekurs, P.E.
RDECOM-ARDEC
Picatinny, NJ

Industry Partners

TECHNO-SCIENCES

GENERAL DYNAMICS
Robotic Systems

- **Prime contractor**
- **System modeling**
- **Interfaces**
- **Control systems**

- **Electrical and mechanical design**
- **Power systems**
- **Hardware fabrication**

GENERAL DYNAMICS
Armament and Technical Products

- **Weapon integration**
- **Fire control integration**
- **Mechanical design**

Background

- Objective to develop and integrate a high performance secondary armament turret onto the Multi-Role Armaments and Ammunition (MRAAS) ATD Turret Mission Module (TMM)
  - Direct-drive motor technology
  - Use TMM controls
  - Ethernet based interface
  - TMM system integration lab (SIL)
- MRAAS was restructured and renamed 120mm Line of Sight/Beyond Line of Sight (LOS/BLOS) ATD
  - Stand alone demonstrator
  - Develop own controls and displays
- Renamed it the Picatinny High Speed Turret

Features/Specifications

WEAPONS:

- XM307/XM312
- Other similar weights/inertias

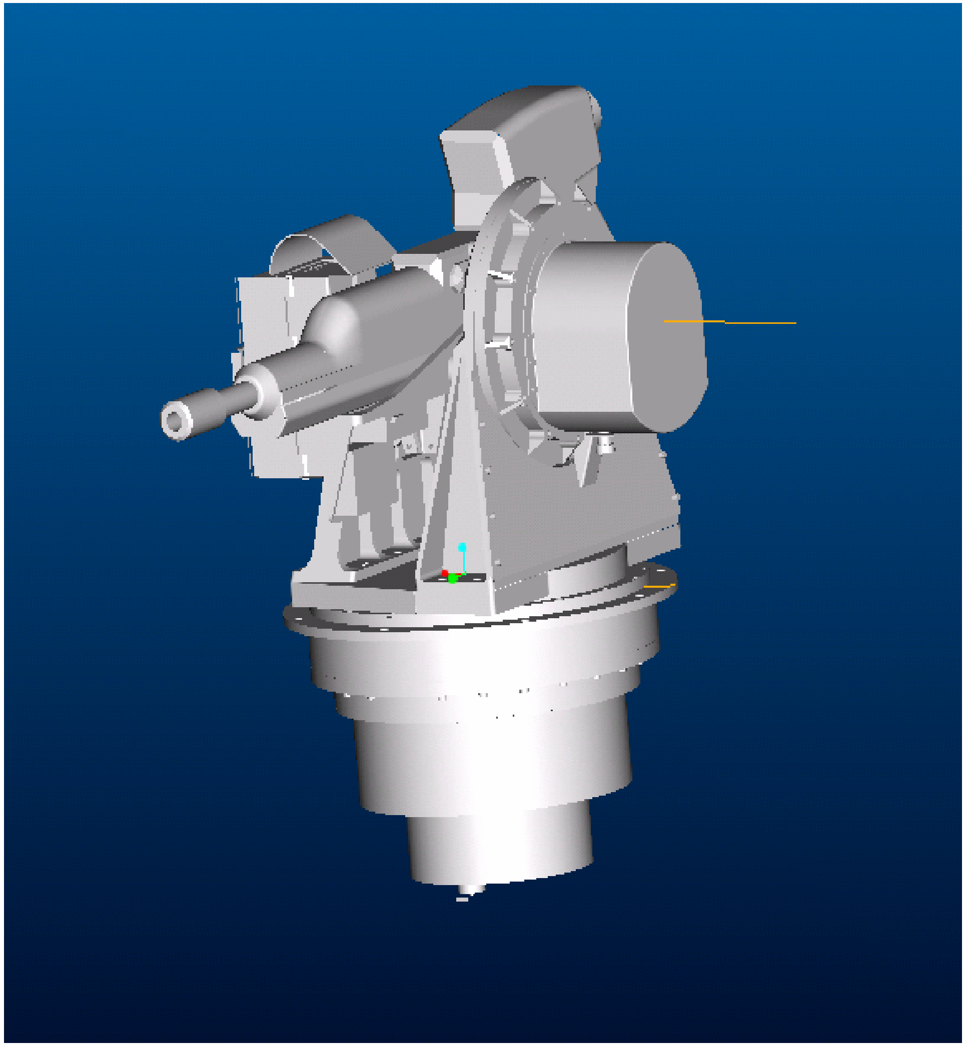
HARDWARE:

- Segmented Array Motors
  - 500 ft-lb torque in Az
  - 208 ft-lb torque in El
- Encoders
  - 200K resolution/turn
- Stabilization sensors
  - 4 KVH-5000 FOGs
  - 2 on cradle
  - 2 on mount
- Az and elevation brakes
- CAN network interface

PERFORMANCE:

- Full 360 degree azimuth
- +55 to -20 deg elevation
- Peak slew rates:
  - 1000 deg/s Az
  - 480 deg/s El
- Stabilization:
  - Feed-forward/feed-back loops
  - min 20db disturbance rejection @ 10Hz
- Weight:
  - Turret: 325 lb
  - ECU&cables: 75 lb
  - XM307 Wpn, FC, ammo: 49 lb
- Size:
  - 22 in diameter footprint
  - <25in above mounting interface
  - 14.5 in intrusion
- Power: 28/270 VDC

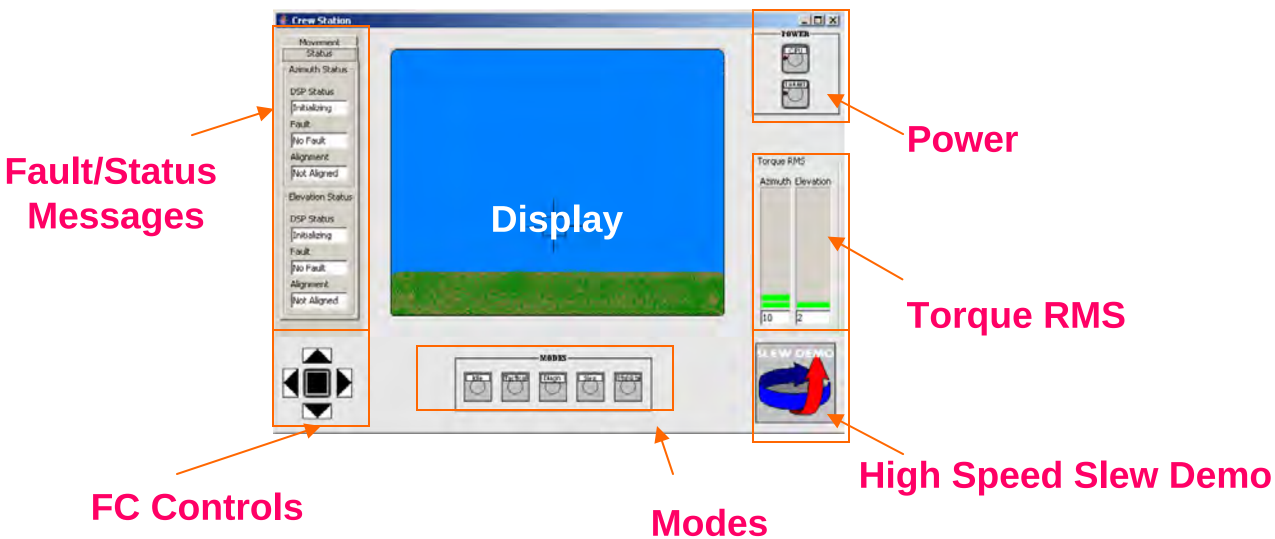
From Design Concept …

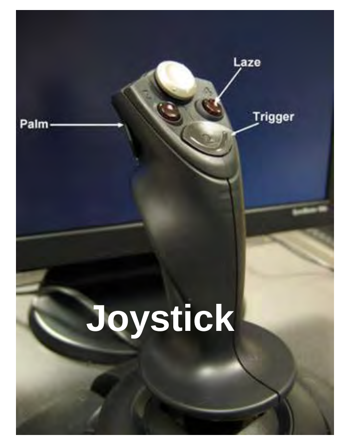


… to Hardware


Weapon Station


Electronic & Power Unit


Fault/Status Messages
Display
Power
Torque RMS
High Speed Slew Demo
FC Controls
Modes


Laze
Palm
Trigger
Joystick

Real-time

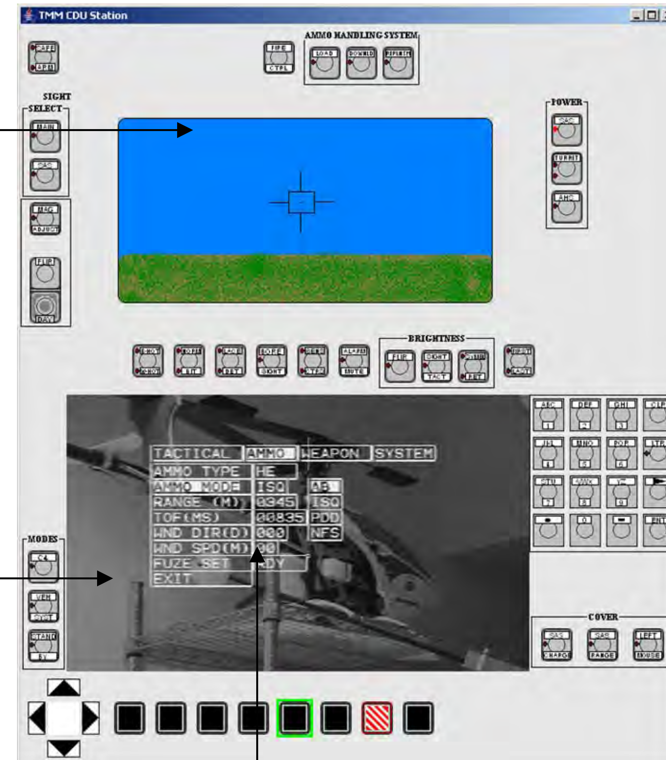
Half-speed

Validated Emulator with ACSW Fire Control Emulator

ACSW FCS

Visualization

Crew Station Display



ACSW Menu Display

SIMULINK / STATEFLOW Model

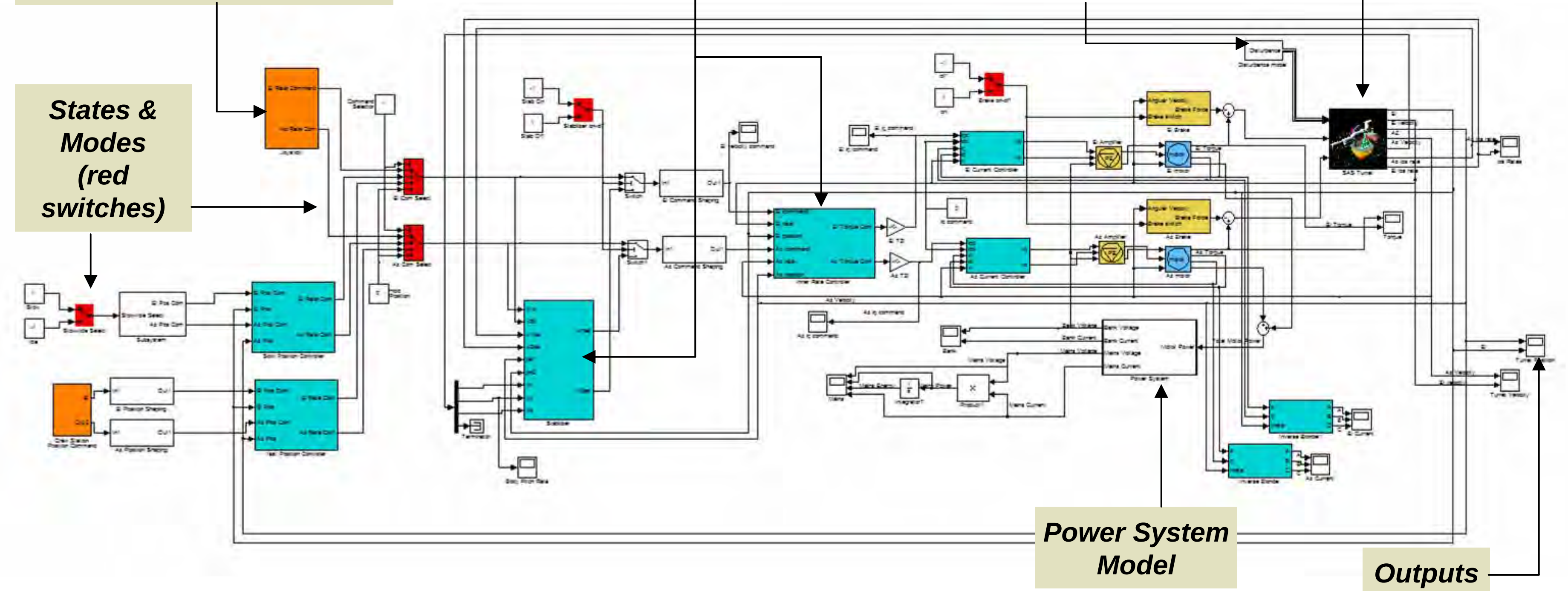
Displacement and Velocity Commands = f(control Input, platform disturbances, Ballistic solution)

Rate and Stab Controllers

Disturbances from Platform

Solid Model

States & Modes (red switches)



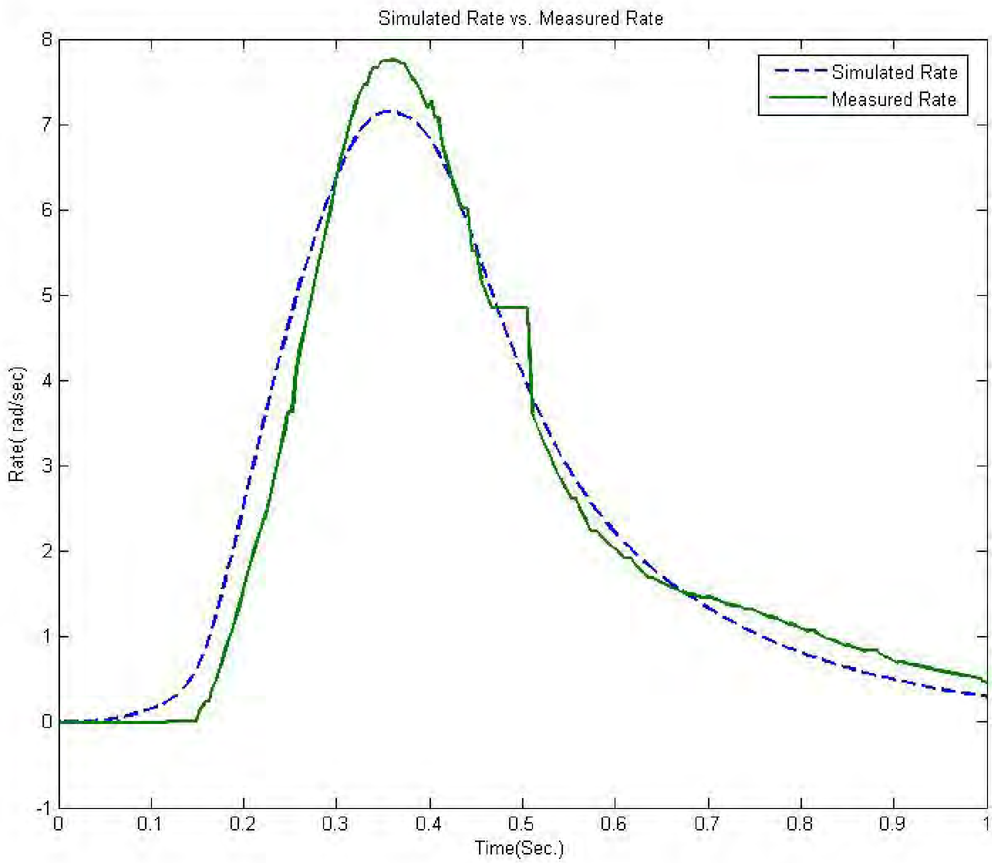
Power System Model

Outputs

Source: Techno Sciences, Inc

Measured vs. Simulated
Case 1

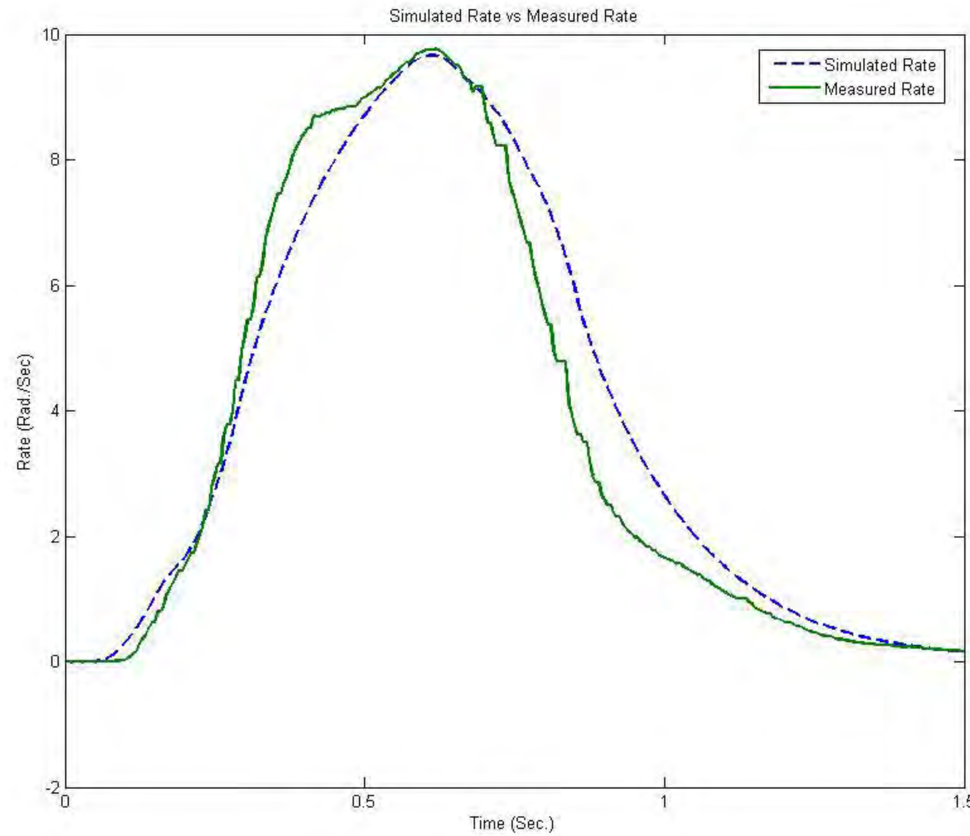
- **Measured azimuth motion commanded using a series of rate commands selected to achieve a slow/fast/slow profile**
- **Discrete nature of rate changes reflected in measured data**
- **Resulting motion**
  - **152 deg in 0.64 Sec**
  - **Avg rate = 238 deg/sec**
  - **Max rate = 447 deg/sec**



Source: Techno Sciences, Inc

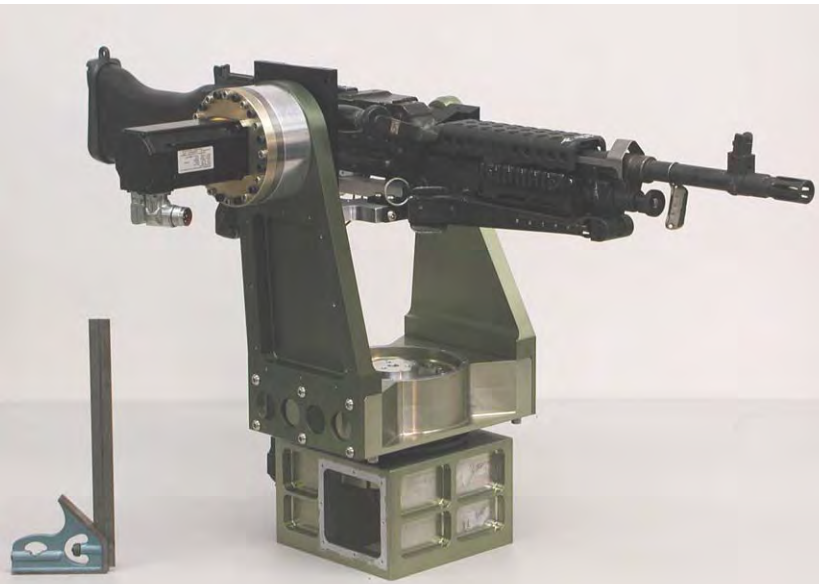
Measured vs Simulated
Case 2

- **Measured azimuth motion commanded using a series of rate commands selected to achieve a slow/fast/slow profile**
- **Discrete nature of rate changes reflected in measured data**
- **Resulting motion**
  - **315 deg in 1.5 sec**
  - **Avg rate = 210 deg/sec**
  - **Max rate = 544 deg/sec**



Source: Techno Sciences, Inc

Picatinny Lightweight Remote Weapon Station



- Leveraged system/emulator to develop control system and user interface
- In-house design with contractor support in metal parts fabrication and crew station development, and control software.
- System Capabilities:
  - -Weight goal: <150 lbs above the roof including gun and 200 rounds
  - -Slew rates: 90 deg/sec in Az and El
  - -2-Axis Stabilization, 5Hz, 20 Db goal
  - -Continuous 360 Degree rotation
  - -Elevation Range +45º to -15º
  - -Integrated Crew Station
  - -Electronics Control Unit

Mounts M240 and M249 machine guns

Summary

- **Weight w/o gun/ammo/fire control:**
  - **400 lb vs projected 451 lb**
- **Slew rates meet objectives values**
  - **500 deg/s average in az**
  - **240 deg/s average in elevation**
- **Elevation range:**
  - **+55 vs projected 60 deg max**
  - **-20 deg vs. projected -20 deg min**
- **Network compatible**
  - **Demo with ethernet**
  - **Fabricated with CAN**
- **Demonstrated electrical integration with ACSW fire control**

Met critical design parameters

Turning Ideas

Into Reality

AMGD

ADVANCED MODULAR GUN DEMONSTRATOR

Using Today's Technology for Tomorrow's Weapon Systems

Presented by
Applied Ordnance Technology, Inc.
40th NDIA GARM Conference
New Orleans, LA
April 2005

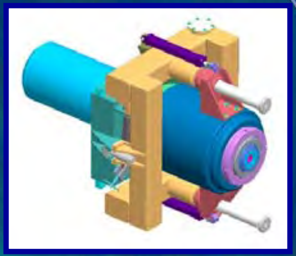
DISTRIBUTION UNLIMITED

Turning Ideas

Into Reality

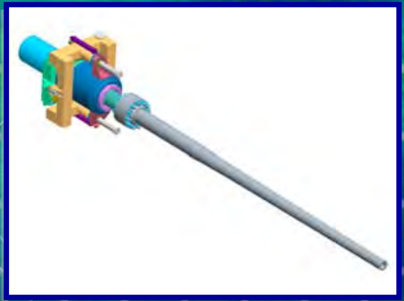
PROGRAM OVERVIEW

- **Modular**
- **Large Caliber**
- **High Performance**
- **Hypervelocity**



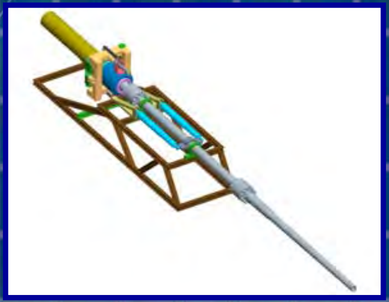
Available Now!

Demonstrated:
- Operating Pressures Up to 100KSI
- 25 shots; 100% Success
- Seal Cartridge Performance
- Chamber / Barrel Connection
- Simultaneous Ignition of Modular Prop Charge
- Chamber Sized for 110-cal. System
- System Can be Upgraded to 200-cal. System



Available FY06.

Upcoming:
- Use Existing Parts
- Test Shots at 100KSI
- Add a Barrel Segment
- Fire Instrumented Projectile



Available FY07.

Near Future:
- Use Existing Parts
- Custom Stand
- Test Shots at 100KSI
- Add Additional Barrel Segment
- Use Larger Volume Chamber
- Launch Instrumented Projectile at High Speeds
- Use Advanced Gun Propellants

Turning Ideas

Into Reality

PROGRAM OBJECTIVES

The program objective is to provide the DoD community with a large caliber, high energy, high pressure, high velocity TEST GUN for advancing gun, projectile, propulsion and ammunition technology.

- **Hypervelocity Research Platform (Large Caliber)**
- **Advanced Projectiles**
- **Advanced Gun Propellants**
- **Advanced Propulsion & Ignition Systems**
- **Wear & Erosion Mitigation**
- **Gun Instrumentation & Safety Systems**
- **Barrel Coatings/Liners**
- **Lightweight Barrel Materials**

DST Fixture Available for Use!

BJT Fixture Available Oct 2005

OUTLINE

AMGD Test Fixture

- GUN DESIGN
- TEST DETAILS
- PROPELLING CHARGE
- INSTRUMENTED PROJECTILE
- AMGD PROGRAM PLAN
- PROGRAM OBJECTIVE

Turning Ideas

Into Reality

GUN DESIGN

AOT designed a large-caliber high energy, high-pressure, large-volume, chemical gun system.

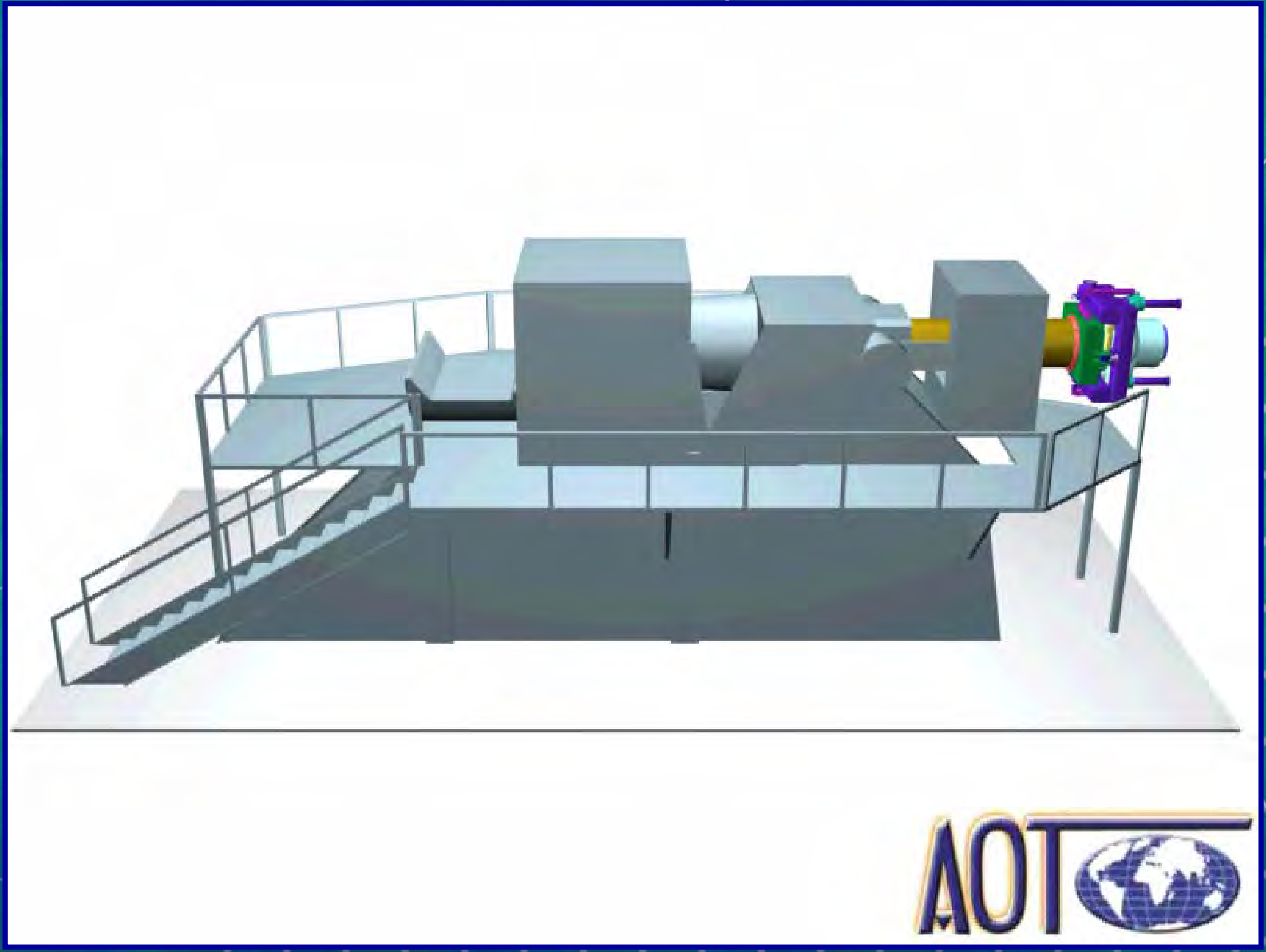
- **High Energy, High Velocity, High Pressure**
- **Separable Chamber**
- **Multiple, Large Volume Chambers**
- **Disposable Seal Cartridge**
- **Segmented, Smoothbore Barrel**
- **Patent 6,571,676**

Test Fixture

Separable Chamber

Seal Cartridge

DST SIMULATION



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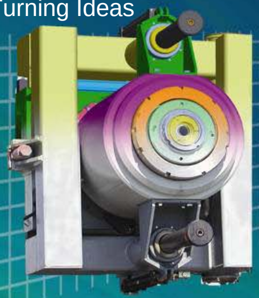


Into Reality

DST Fixture

Objectives:

- Seal Cartridge Performance
- Chamber Pressures Up to 100 KSI
- Chamber / Barrel Connection
- Simultaneous Ignition of Modular Prop Charge

Fixture Features:

- Full-scale 5-in. Gun Parts
- Nozzle/Throttle to Simulate P-t Curve
- Automated Chamber / Barrel Connection

Sequence of Pictures Showing Fixture Opening

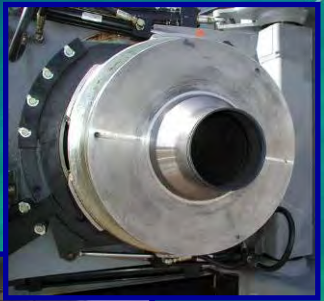




DST RESULTS

- **Test Performed at NSWC-DD**
- **Conducted 25 Shots**
- **Pressures Ranging from 40-100KSI**
- **Seal Cartridge Performance Exceptional**
- **Successfully Demonstrated Chamber/Barrel Coupling**
- **Modular Prop Charge Performance Repeatable**

Chamber w/ Seal



Coupler

Fired Seal Cartridge

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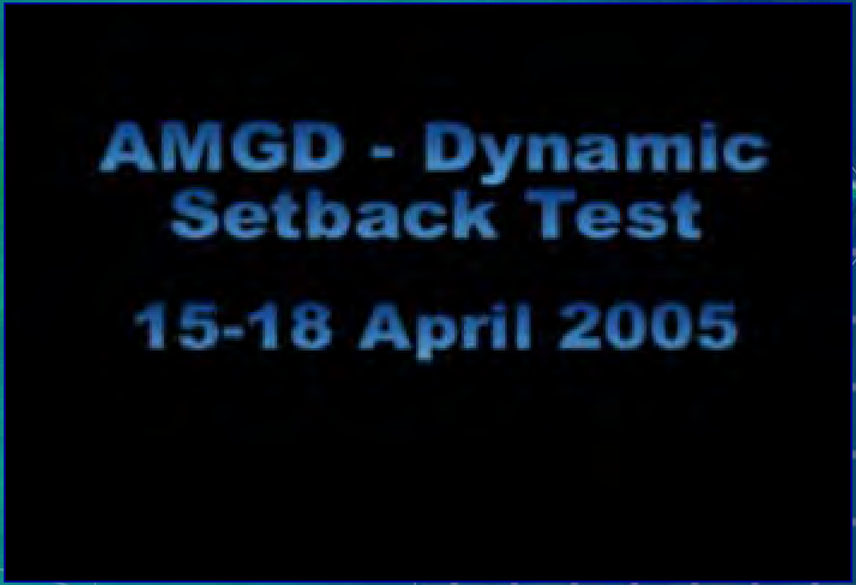
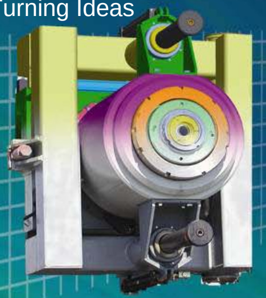
SETBACK TEST FIRING



PROPELLING CHARGE

- **Modular Prop Charge**
- **Simultaneous Module Ignition**
- **Consumable Case**

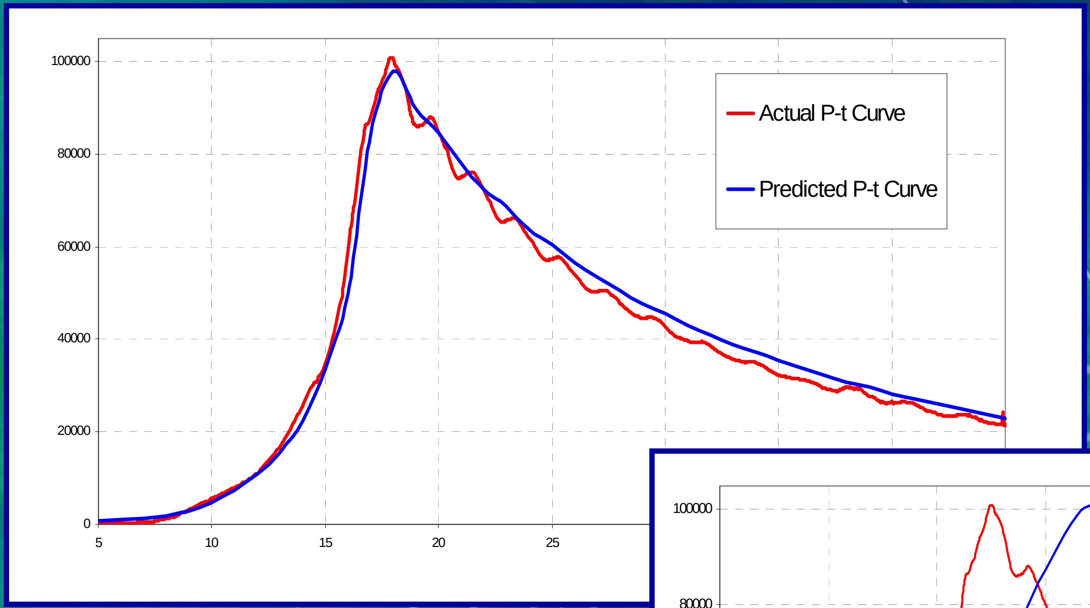
Turning Ideas



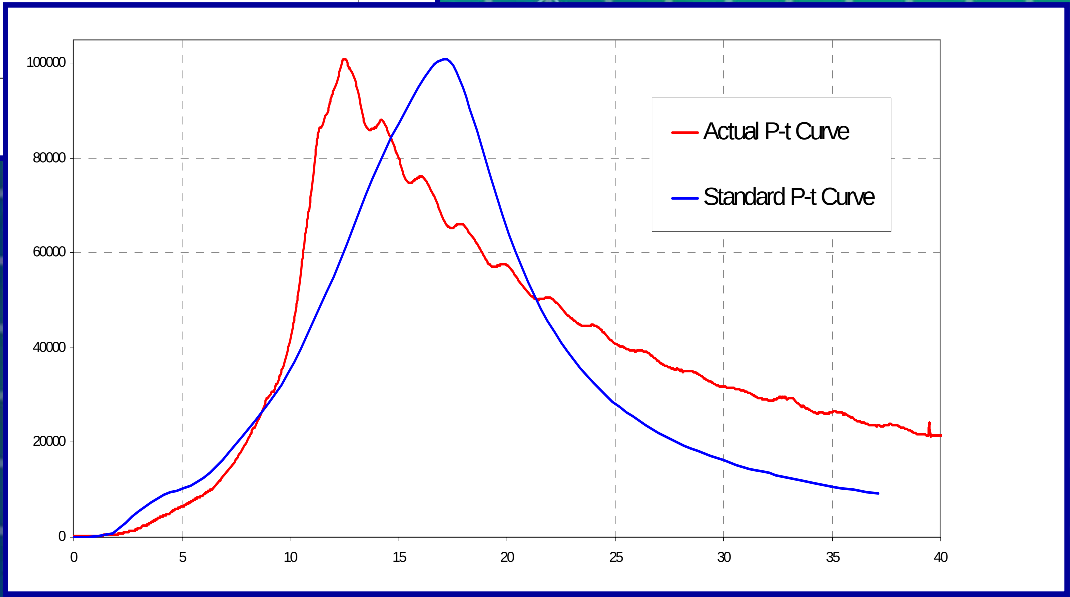
Into Reality

PROPELLING CHARGE

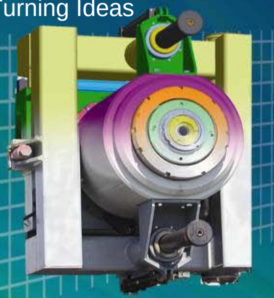
DST Test Results – April 2005
Prop Charge Performance



DST P-t Curve
vs.
Standard P-t Curve



Turning Ideas



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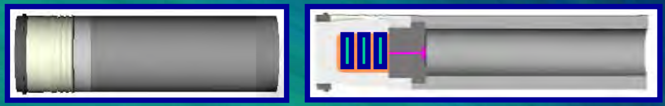
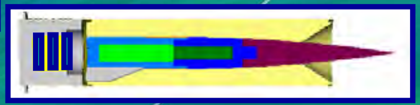
INSTRUMENTED PROJECTILE

Instrumented Monolithic Pusher Test Projectile (IMPTP)



Instrumented Pusher Assembly (IPA)

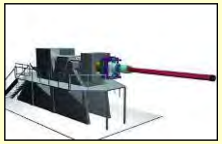
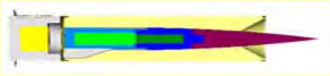


Instrumented Long Range Test Projectile (ILRTP)

- Capture Interior and Exterior Ballistics Data
- Leverage Army Instrumentation Expertise
- Utilize Existing, Gun-proven Sensors and TM Solutions
- Embed Instrumentation in Modular Fashion
- Conduct Hypervelocity Research for Large Caliber Projectiles

State-of-the-Art + Timely + Robust + Low Cost = Low Program Risk!

AMGD PROGRAM PLAN

Test Name	Test Gun Configuration	Projectile	Propellant	Status
Proof-of-Concept	Army Test Asset 	None	M30A1	Completed
Setback Test	5-in., 50L chamber 	None	NACO	Completed
Barrel Joint Test	5-in./70-cal., 50L chamber 	IPA 	Advanced Gun Propellants	FY06 Q1
Propellant Characterization Test	5-in./110-cal., 50L or 100L chamber 	IMPTP 	Advanced Gun Propellants	FY06 Q4
155mm Long Range Testing	155mm/200-cal. 	ILRTP 	Advanced Gun Propellants	FY09 Q2

AMGD USES

Test Platform To:

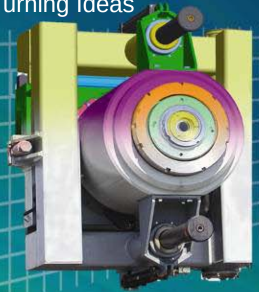
- Validate Modeling & Simulation
- Develop Hypervelocity Projectile
- Conduct High Velocity Penetration Effects
- Advance Gun Propellants
- Evaluate Instrumentation High-G Survivability
- Evaluate Precision Guided Munitions
- Study Barrel Life
- Test Wear & Erosion Mitigation
- Advance Gun Barrel Technology

DST Fixture
Available for Use!

BJT Fixture
October 2005!

XLR Fixture
July 2006!

Turning Ideas



Into Reality

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ABRAHAM OVERVIEW

Robert Daunfeldt

Battle Group ”Force protection”

A DIFFERENT PROBLEM !

The need to develop technology and combat-principles against many small and simultaneously incoming targets

ABRAHAM – Short Range Air Defence

Combating a large number of simultaneously incoming small targets,
i.e. Cruise Missiles

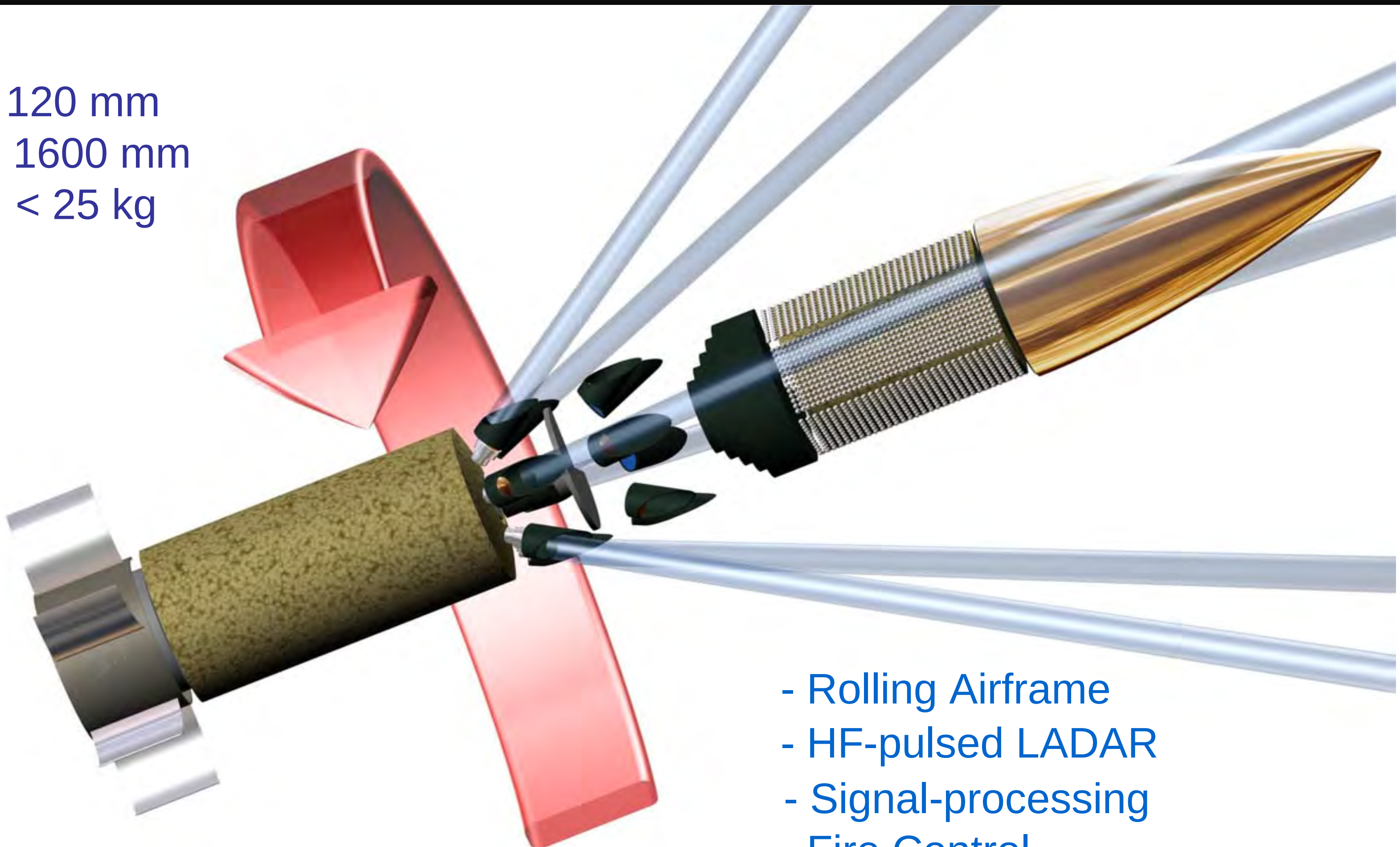
- Unguided Rocket – Fire and forget
- High Velocity – Short time to reach target
- Directed Warhead – Large stand off
- High Rotation Rate – Pinpoint target

Launcher Concepts

- Lightweight Launcher Concepts
- Recoiless Launch
- Could use existing Mount
- Rocket Motor provide fly-out speed

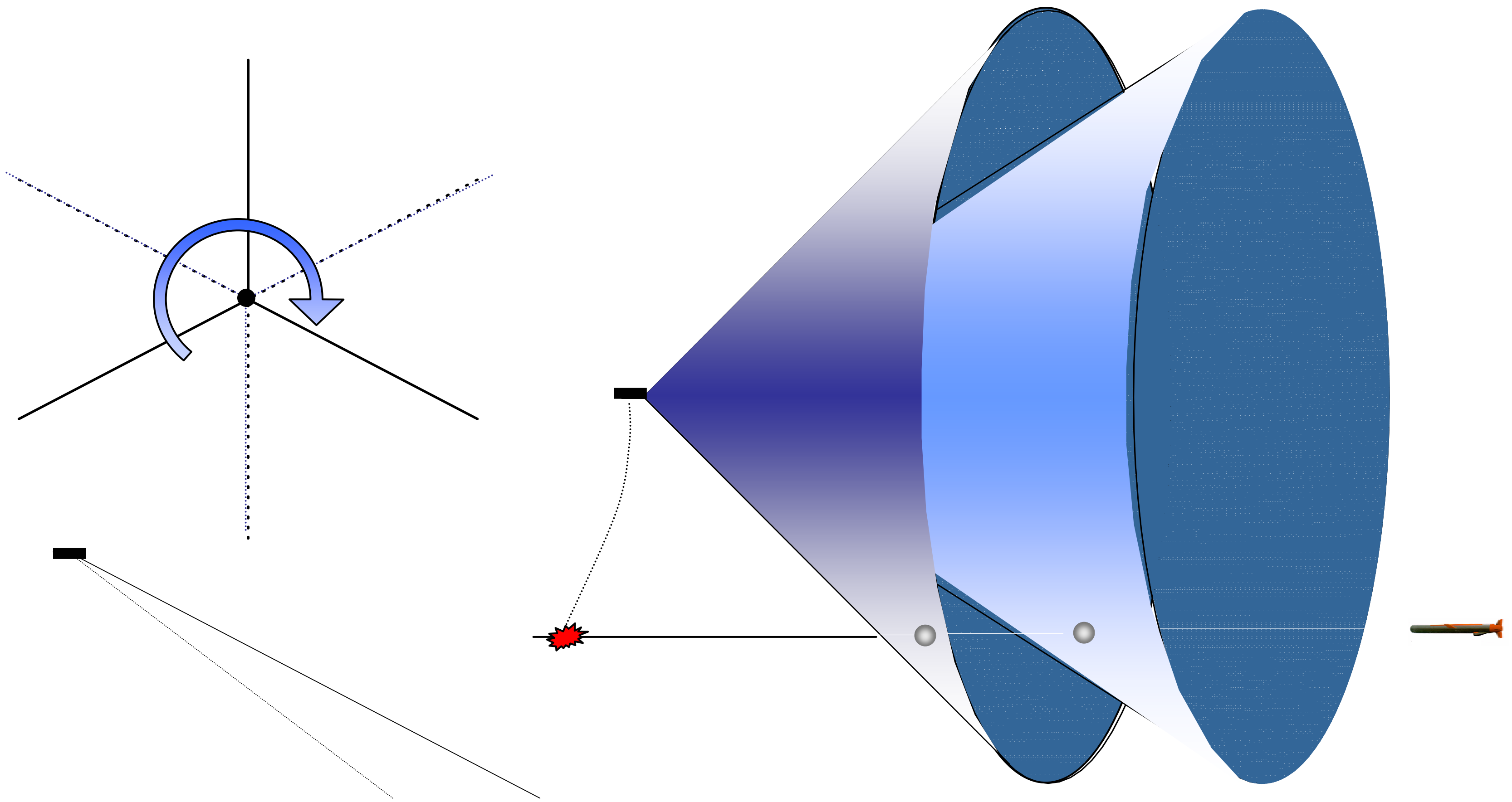
Rocket Functionality

Calibre: 120 mm
Length: 1600 mm
Weight: < 25 kg



- Rolling Airframe
- HF-pulsed LADAR
- Signal-processing
- Fire Control
- Advanced Warhead

TARGET ACQUISITION



Air Threat

Saturation Attacks

10:s / 10 km^2

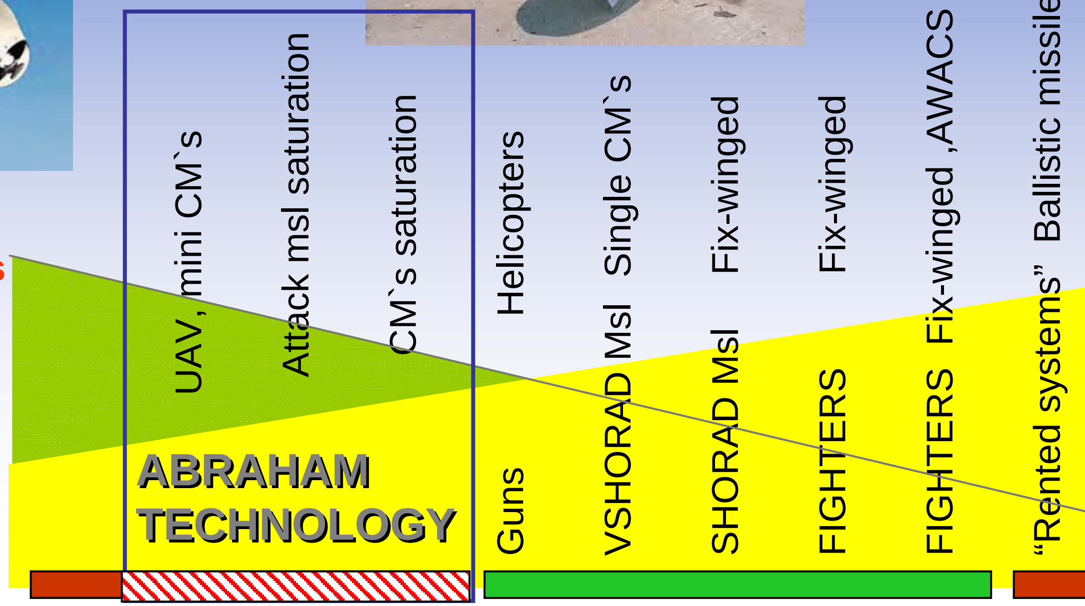
Passing/Attacking

100:s / km^2

10:s / world

Protection systems

Combat so that probability of own survival is maximized



Air-Defence Systems

Combat as soon as possible

SUCCESSFUL TESTS

RANGE

FOCUSING

ACCURACY

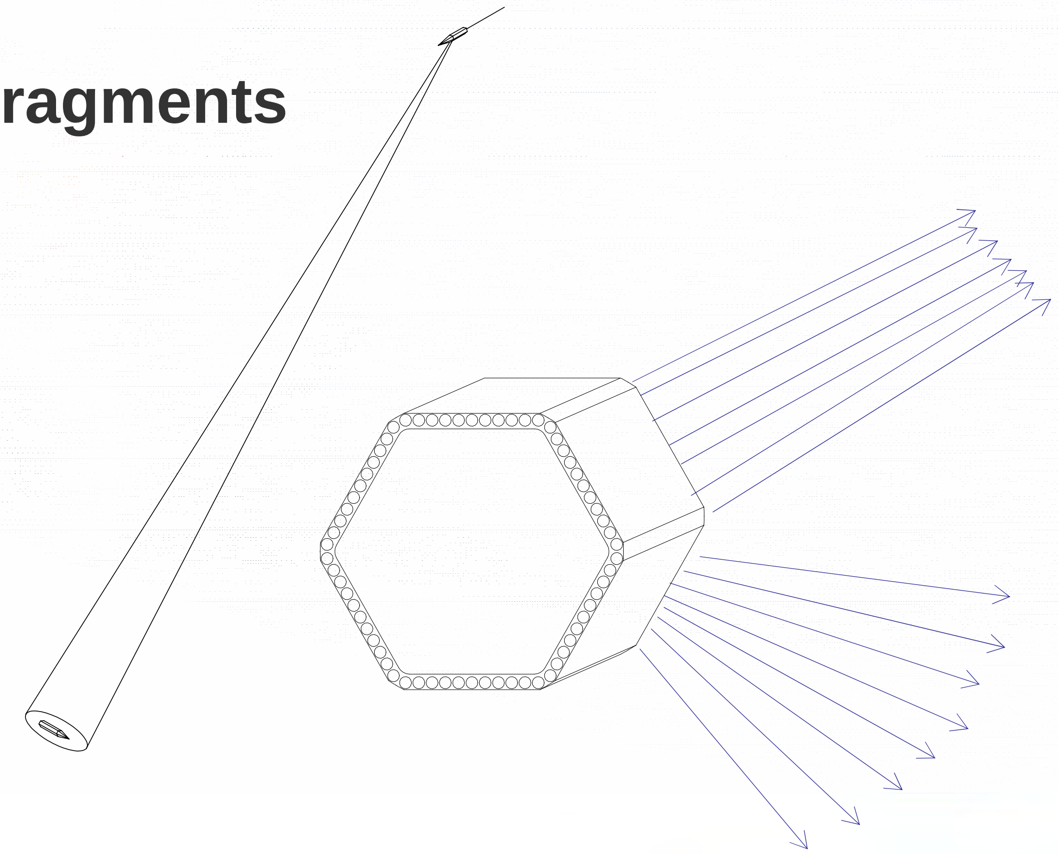
PENETRATION

ABRAHAM Warhead

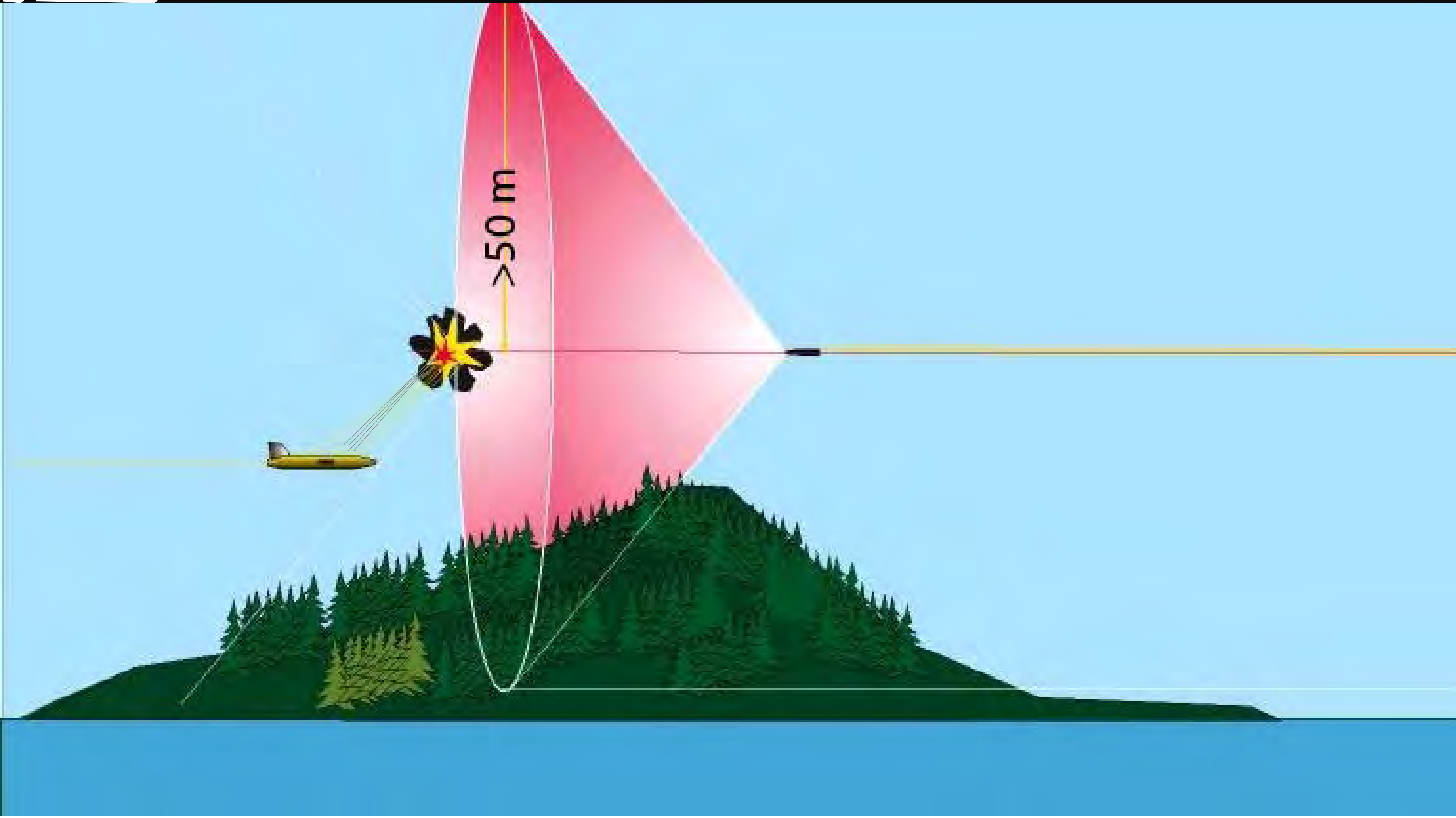
- Airframe-integrated, 10 kg

- Tungsten Pre-Formed Fragments

- Long Range
- Short Range



Stand-Off Capability



BOFORS DEFENCE

SHORT RANGE MODE

BOFORS DEFENCE

FMV

LONG-RANGE MODE

AFTER TEST

WITHNESS-PLATES ~1000kg


20 mm Steel

30 mm STEEL at ~3m

AIR THREAT INCREASES

Saturation Attacks

Passing/Attacking

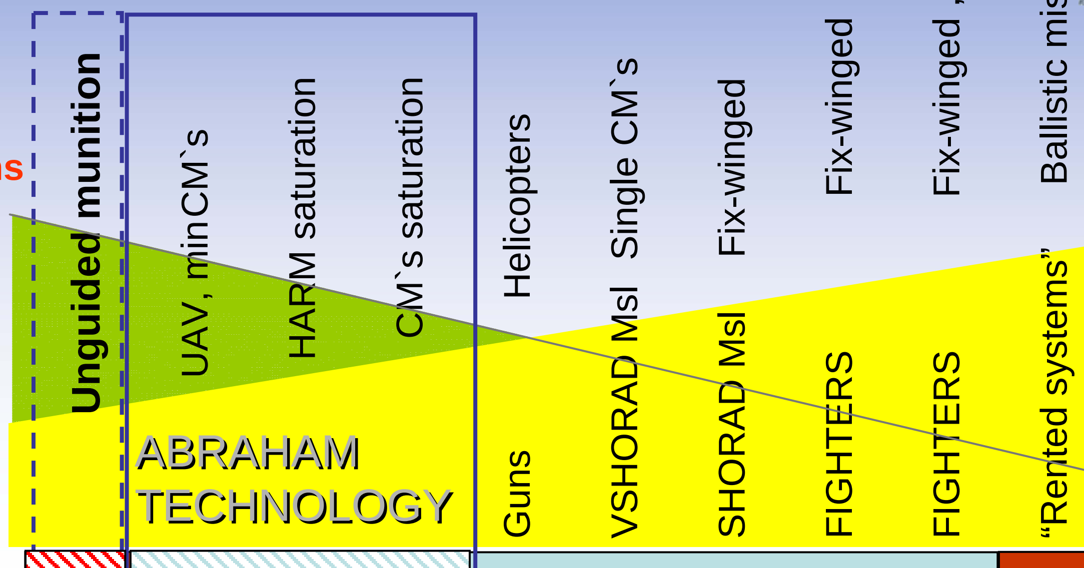
100:s / km^2

10:s / 10 km^2

10:s / world

Protection systems

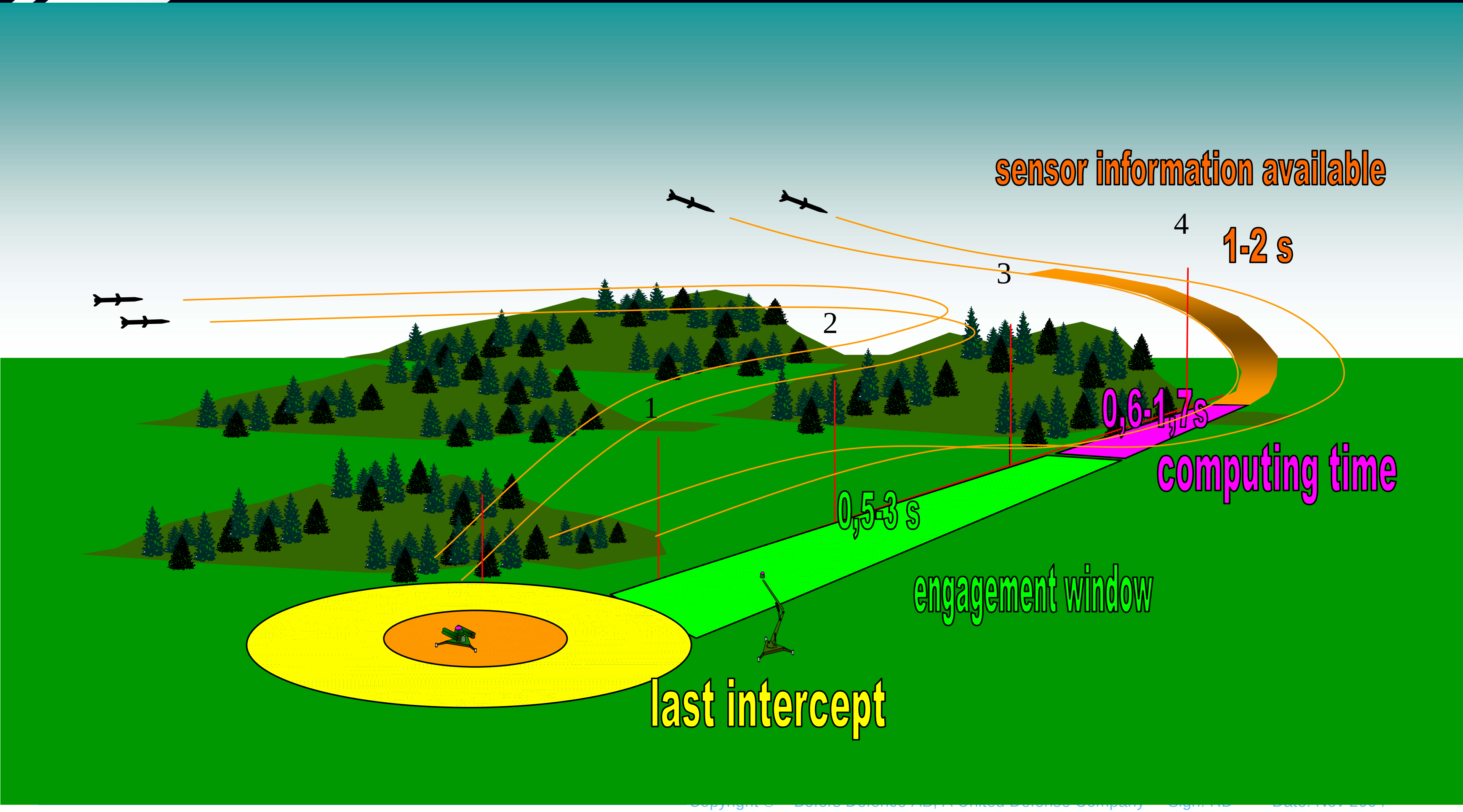
Combat so that probability of own survival is maximized



Air-Defence Systems

Combat as soon as possible

Engagement Planning



LEO BETWEEN PLATFORMS

DISTRIBUTED CLUSTER-INTELLIGENS

- DECISION SUPPORT IN A LIMITED AREA

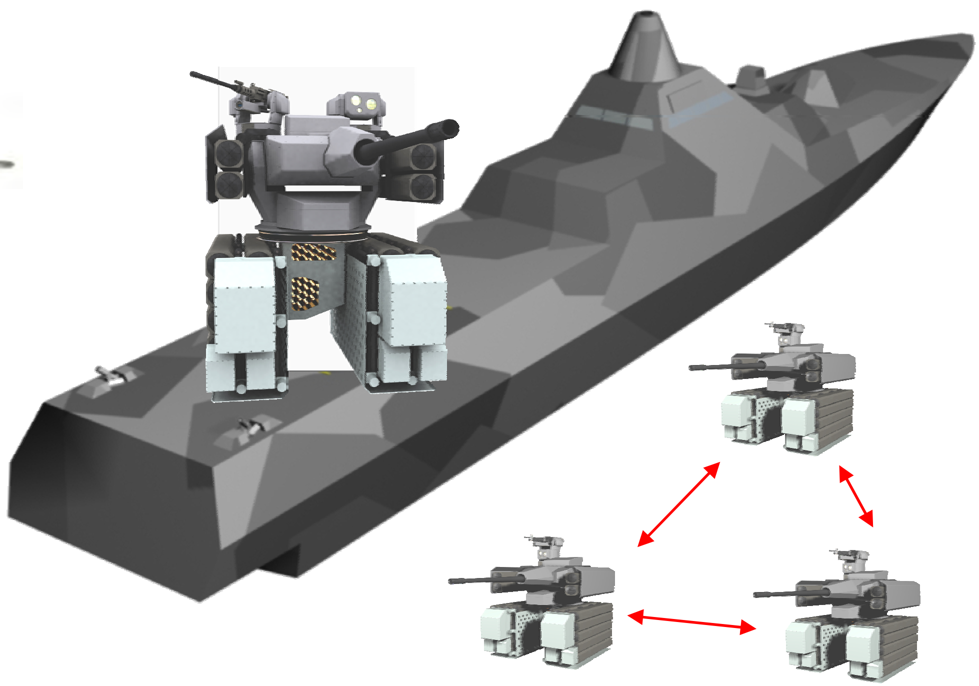
- OPTIMISES & MANAGES SENSORS AND WEAPON IN A CLUSTER

Window of opportunity

ABRAHAM Concepts

Land Platform

Naval Platform

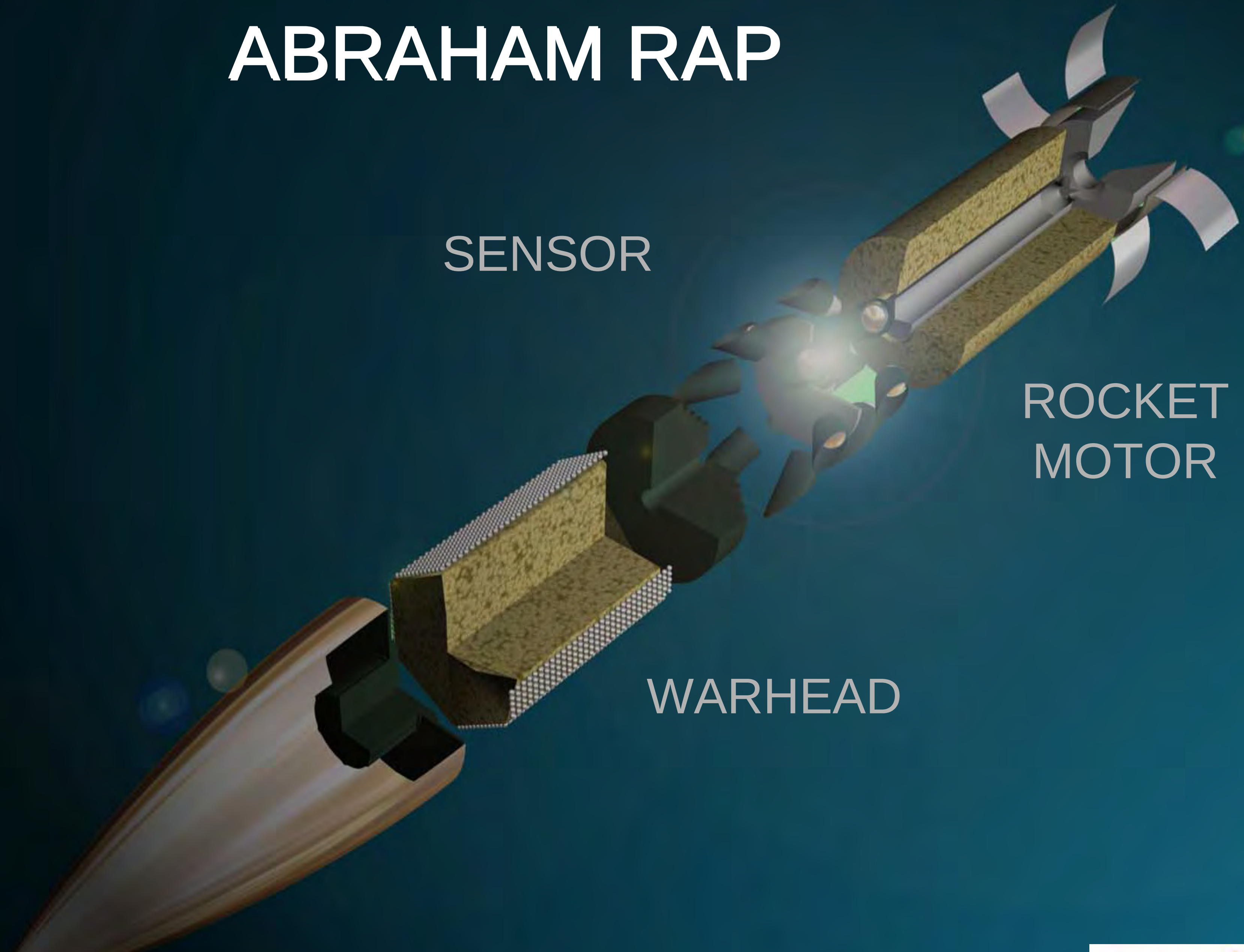


In a Cluster

Air Platform

ABRAHAM

ABRAHAM RAP



QUESTIONS?

TECHNOLOGY FOR THE SMART ROCKET LAUNCHER:
THE SYSTEM ENABLER FOR THE 21ST CENTURY

DON DAVIS
AVIATION & MISSILE RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
REDSTONE ARSENAL, AL
256-876-5089
E-mail: don.davis1@us.army.mil

DISCLAIMERS

- WE WILL PRESENT TECHNOLOGY TRENDS:

  WE WILL NOT PRESENT PROGRAM PLANS!
- NOTHING SAID HERE IS TO BE TAKEN AS A FORMAL SOLICITATION
- I AM NEITHER A MISSILE MAN NOR A ROCKET SCIENTIST:

I AM A LAUNCHER ENGINEER WITH 30+ YEARS EXPERIENCE!

GOALS OF PRESENTATION

- **INFORM COMMUNITY**
  - CURRENT DESIGN DIRECTIONS
  - AREAS THAT NEED HELP
- **RAISE AWARNESS OF 2.75” ROCKETS**
- **INSPIRE THOUGHT**
  - WHAT CAN BE DONE ONCE SMART LAUNCHER IS AVAILABLE?

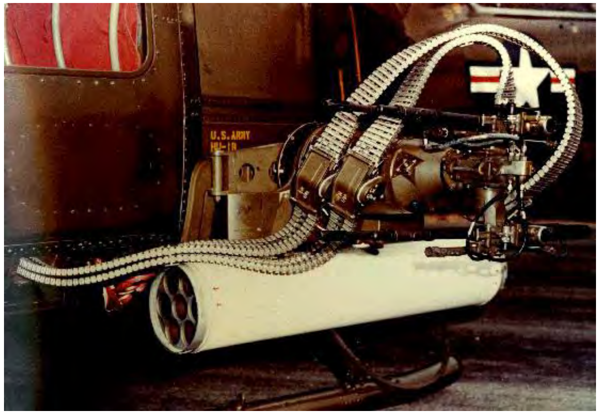
YOU TELL US!

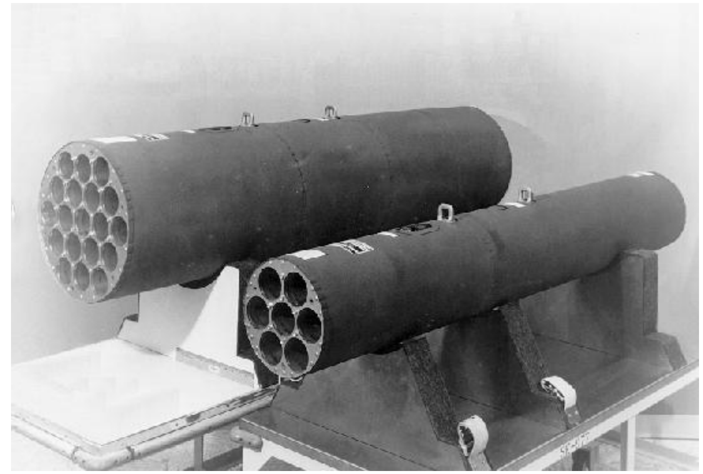
ROLES OF ROCKETS

- **TRADITIONAL**
  - HIGH VOLUME FIRE POWER
  - AREA ENGAGEMENT
  - SUPRESSION OF ENEMY
- **EMERGING**
  - PRECISION ENGAGEMENT
  - SMALL MUNITIONS ON SPECIFIC TARGET
- **A VERY BRIEF HISTORY:**

HISTORY OF 2.75" ROCKETS

HISTORY OF 2.75" LAUNCHERS





M21 Armament Subsystem with M134 minigun and M158 Rocket Launcher

WHY SMART LAUNCHERS?

NEW SMART ROCKETS REQUIRE SMART LAUNCHER SUPPORT!

- **APKWS, LASER GUIDED, BLOCK I**
  - TURNS-ON WITH ROCKET IGNITION & ACCELERATION
  - NO LASER CODE CHANGES
  - NO NAVAGATION INPUT
  - NO PRE-LAUNCH CHECK-OUT
- **APKWS, BLOCK III & FUTURE SMART ROCKETS**
  - PRE-FIRE GUIDANCE TURN-ON
  - REQUIRE COMPLETE COMMUNICATIONS
- **<u>PROBLEM:</u> LAUNCHERS TO SUPPORT BLOCKIII DOES NOT EXIST!**

WHY SMART LAUNCHERS?

NEED FOR STANDARDIZE PLATFORM ELECTRICAL INTERFACE

- CURRENT ARMY LAUNCHER HAS 2-PLUG RMS
- CURRENT AF/NAVY HAVE 5-PIN CONNECTOR
- AH-64D & FUTURE ROTARY WING AIRCRAFT WILL UTILIZE MIL-STD-1760 CONNECTION

GENERAL NEW LAUNCHER ISSUES

- **DROP MK40 ROCKET CAPABLITY**
  - THEY ARE OLD AND MOSTLY GONE
- **IMPROVE FIRING CIRCUIT DURABLITY**
  - LAUNCHERS ALMOST ALWAYS FAIL IN FIRING CIRCUIT
- **IMPROVE RIPPLE-FIRE DURABLITY**
- **RETAIN LOW COST, LIGHTWEIGHT, NON-REPAIRABLE APPROACH**
  - ALUMINUM BASIC STRUCTURE TECHNOLOGY
  - 4, 7, AND 19 TUBE VERSIONS

SMART LAUNCHER ENABLING FEATURES

- **MIL-STD-1760 PLATFORM INTERFACE**
  - MOVES RMS FUNCTIONS INTO LAUNCHER ELECTRONICS MODULE
- **TUBE TO ROCKET ELECTRICAL INTERFACES**
  - PORT TO PROVIDE POWER AND COMMUNICATION
  - MUST BE COMPATIBLE WITH CURRENT REMOTE SET FUZING
- **AUTOMATIC ROCKET IDENTIFICATION**
  - “INFINITE” OR “ZONELESS” LAUNCHER

MIL-STD-1760 INTERFACE LAUNCHER ELECTRONICS

- **NAVY DEMONSTRATED LAUNCHER IN 1999**
  - FIRED ROCKETS & SET FUZES
  - MAINTAINS MANUALLY INPUT ROCKET ON-BOARD INVENTORY
  - UPGRADED & IN FINAL DEVELOPMENT
- **ARMY & NAVY COOPERATED ON 4-TUBE, HURL, ELECTRONICS PACKAGE**
  - DEMONSTRATED ROCKET FIRING
  - SURVIVED TACTICAL VIBRATION TEST
  - INTERFACED THROUGH HELLFIRE SHOTGUN CONNETOR
- **PROJECTED LOW UNIT COST IN PRODUCTION**
  - BASED ON “COTS” AUTOMOTIVE CPU

POWER AND COMMUNICATIONS PORT

NAVY DEVELOPING THIS INTERFACE FOR OF LOGIR

– LOGIR PROVIDES INITIAL APPLICATION

– MECHANICAL INTERFACE & SOFTWARE PROTOCOLS WILL BE ESTABLISHED

– MUST PASS COMMUNICATION BOTH WAYS

– WILL LEAD TO A MORE STANDARD SMART ROCKET LENGTH

Navy Launcher Evolving to Support 2.75” Guided Rockets

An MH-60-borne launcher will help demonstrate LOGIR effectiveness

Extended length launcher (LAU-61 D/A) to incorporate a guidance interface unit (GIU) for Low-cost Guided Imaging Rocket (LOGIR) development, testing, and demonstration.

Will enable pre-launch seeker configuration, calibration, and protection.

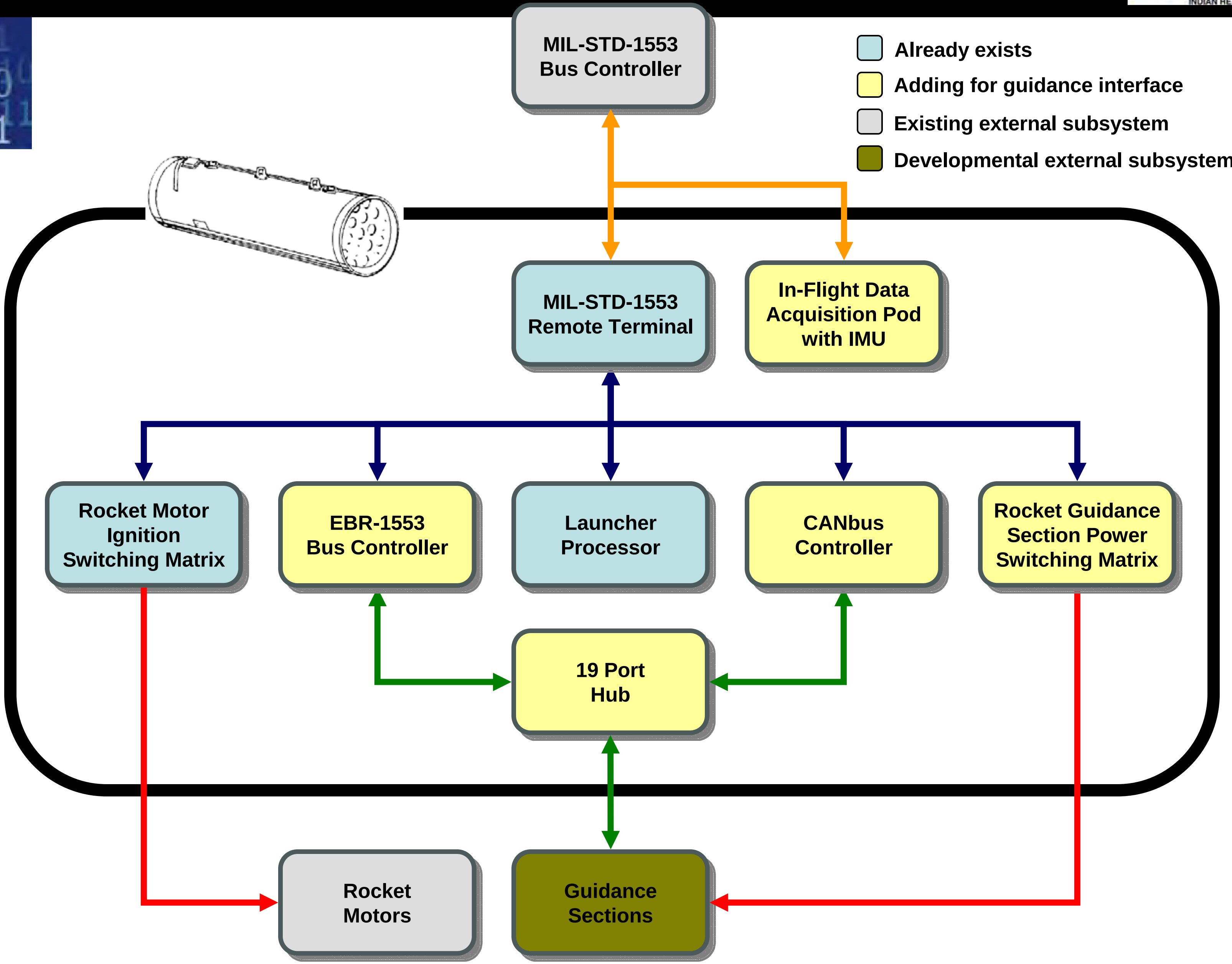
The electrical portion of the GIU, building on existing Smart Launcher electronics, will provide power to, and robust, high speed digital communication with LOGIRs.

<u>GIU at-a-glance</u>

- Guidance section keyway
  - Positions LOGIR within .007” radially (roll axis)
  - Blind-mating electrical contacts
- Seeker window protection device
  - Rocket back blast shielding
  - Camera calibration
- Inertial measurement unit
  - Transfer alignment from platform to launcher to rocket
- MMSI-supportive interface
  - EBR-1553 10 Mbit/s network
  - CANbus for store configuration
  - High bandwidth analog line
  - 28 VDC power

POC: Kenneth Johnson, (301) 744-4946

Guidance interface unit architecture



AUTOMATIC ROCKET IDENTIFICATION

- **GOAL: ANY ROCKET IN ANY TUBE AT ANY TIME**
  - LAUNCHER DETERMINES TYPE AND STORES LOCATION
  - CREW PROVIDED WITH TYPES AND COUNTS
  - PICK TYPE FOR ENGAGEMET
- **POTENTIAL TECHNOLOGIES**
  - SIGNAL THROUGH THE POWER AND COMMO PORT
  - BAR CODES
  - RF-ID TAGS
  - “OTHER”
- **GENERAL REQUIREMENTS**
  - NO ROCKET-SIDE POWER
  - ANY READER MUST FIT BETWEEN TUBES
  - ANY READER MUST BE ROBUST ENOUGH FOR **TACTICAL** LAUNCHER ENVIRONMENT
  - NEEDS TO BE RETROFITABLE TO EXISTING ROCKET STOCKS

KNOWN AUTOMATIC ROCKET IDENTIFICATION TECH PROBLEMS

- **ID THROUGH COMMO PORT**
  - NOT EASILY RETROFITABLE
  - WOULD REQUIRE UMBILICAL FOR ALL ROCKET/WARHEAD COMBINATIONS
- **BAR CODES**
  - REQUIRES <u>CLEAR</u> AND <u>CLEAN</u> OPTICAL TUBE WINDOW
    - USED LAUNCHERS CAN BE VERY DIRTY
  - “GROCERY STORE EXPERIENCE” SAYS POTENTIALY NOT RELIABLE ENOUGH FOR TACTICAL APPLICATION
- **RF-ID TAGS**
  - REQUIRE AN RF WINDOW IN TUBES
    - DIRTY TUBE NOT AN ISSUE FOR RF-ID
  - METAL BACKING (i.e. MOTOR TUBE) CAUSES READING
  - PROBLEMS
- **OTHER TECHNOLOGIES?**

SUMMARY

- ROCKET HAVE STRONG PAST AND POTENTIAL FUTURE
- WE'VE SHOW WHERE CURRENT DESIGNS & TECHNOLOGY ARE GOING
- WE HAVE SHOWN THAT AUTO-ID APPROACH IS STILL UNDEFINED

WHY IS ALL OF THIS IMPORTANT?

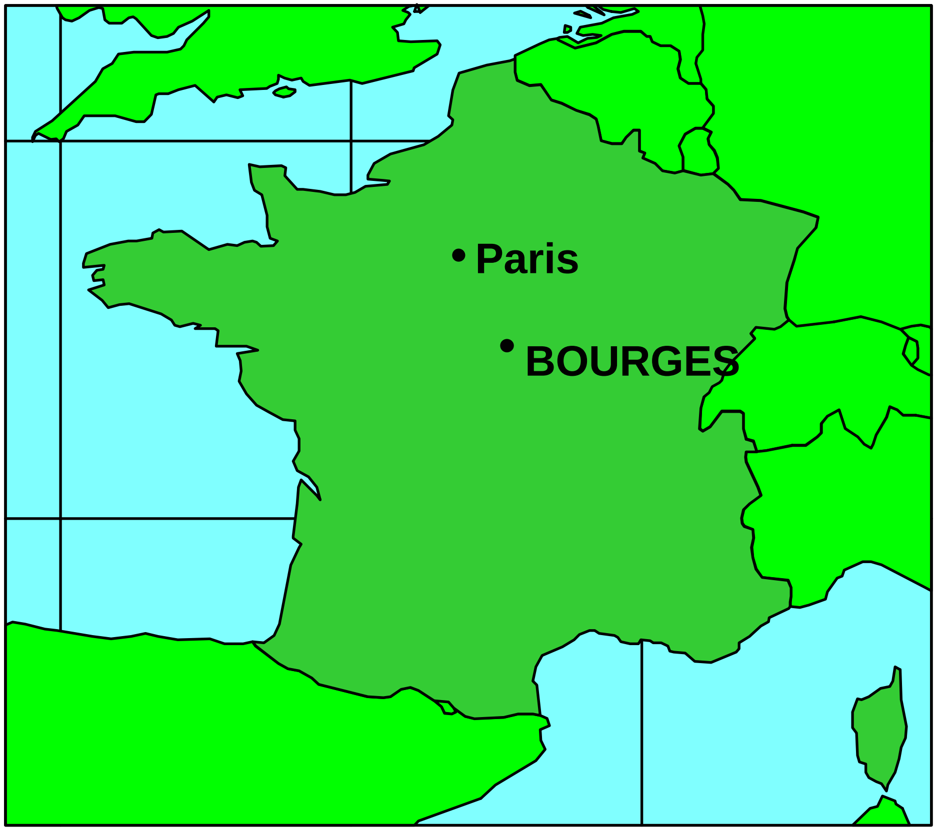
THIS GUY NEEDS OUR HELP!

40th Annual Armament Systems
Guns-Ammunition-Rockets-Missiles
Conference and Exhibition
April 25 –28, 2005

40mm CTWS Supporting UK and France

CTA INTERNATIONAL

CTA International



- CTAI is a joint venture company 50/50 BAE Systems and Giat Industries.
- Dedicated team, 40 strong, British and French engineers and scientists based in Bourges, France.
- Whole company focused on development of 40mm Cased Telescoped Weapon System.
- Technology Background funded from industrial investment.

Private Venture Investment since 1994 - >€52M

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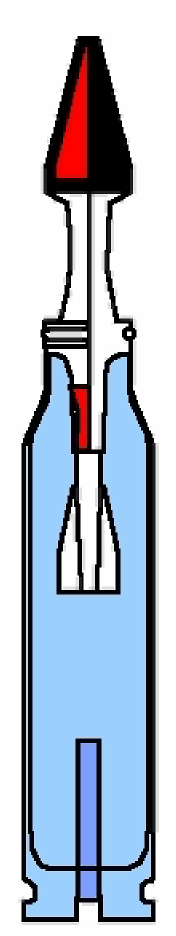
Cased Telescoped Technology

Principle of Technology

‘Telescoped’ ammunition



30% saving in volume for the same performance

30% more performance for the same volume

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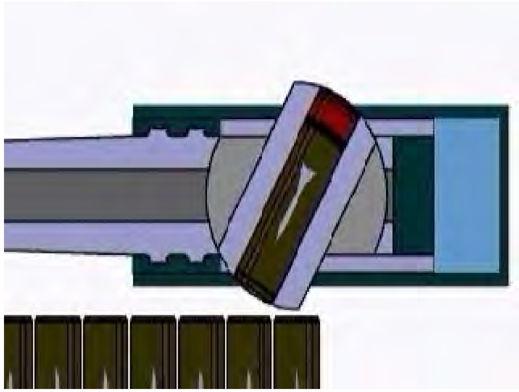
Cased Telescoped Technology

Cylindrical cartridges enable a much simpler Cannon mechanism
As a consequence the overall cannon system is substantially smaller

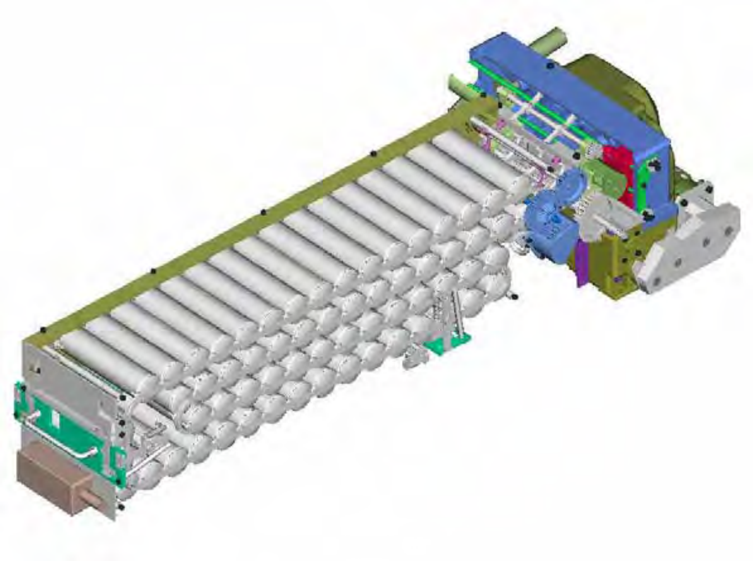
Rotating chamber and ‘push through’ concept



TA INTERNATIONAL

Linkless Ammunition Feed Technology

- Compact
- Reduced gunner workload
    - > Easy loading and unloading
    - > Remote operation



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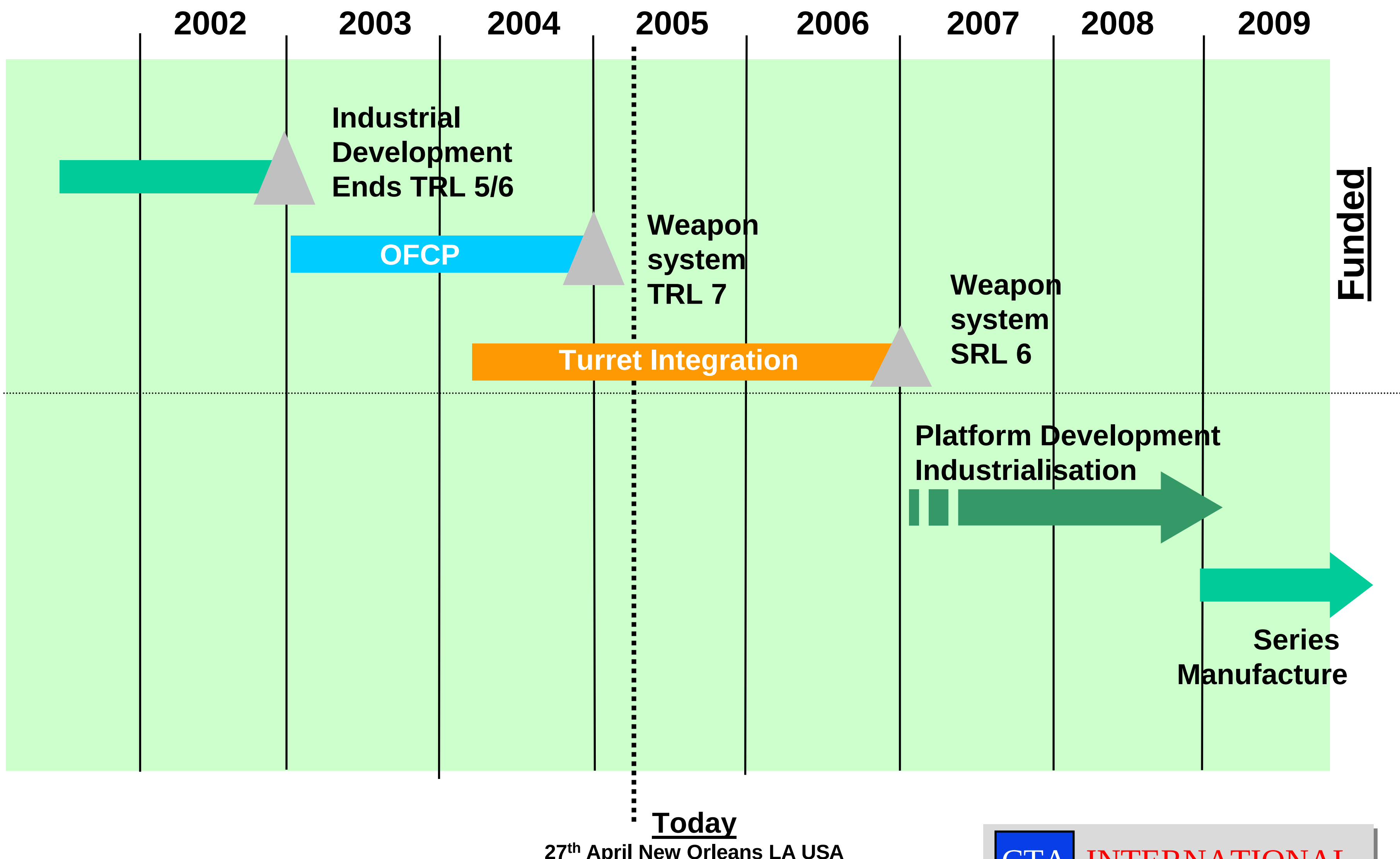
CTWS Route Map



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The Objective Future Cannon Programme(OFCP)

- Started in September 2002; joint funded by UK MoD, French DGA and CTAI
- Preceeded by a system lethality system trade study which selected 40mm CTWS as the optimal cannon system to satisfy the future lethality requirements of UK and France.
- In 2002 UK and French Governments co operate on 40mm CTWS
- Driven by the Requirements of:
  - UK Warrior, FRES
  - DGA VBCI, EBRC
- Objective was to demonstrate TRL7 by the end of 2004 total - budget 9M€
- Customers are committitted to share deliverables with other nations

France and the UK sign deal for 40mm CTWS

The French and UK governments have signed an agreement with CTA International (CTAI) to fund a risk-reduction programme for the 40mm Case Telescoped Weapon System (CTWS).

The objective is to ensure that the design is technically secure when the two armies need to select the armament for new platforms or mid-life update programmes.

According to David Leslie, CTAI managing director: "This demonstration of support from both governments is a major milestone in CTAI's programme. The joint contracts will enable us to work closely with the procurement agencies and user groups from both countries in an environment of shared information."

The British Army is expected to select the 40mm CTWS for the projected Warrior infantry fighting vehicle (IFV) upgrade and for at least one member of the projected Future Rapid Effects System, for which the user requirements document has recently been issued.

The French Army is expected to specify the weapon for the projected Engin Blindé à Roues de Contact, which is currently at the study phase. Versions of this could include a 6 x 6 model with a 40mm CTWS installed in a remote-controlled turret (*Jane's Defence Weekly* 10 April).

The CTAI work will include not only the weapon but also the ammunition-handling system and the two warshot natures of ammunition: armour-piercing fin-stabilised discarding sabot and a general-purpose round of the air-bursting munition type.

Under the terms of the contract, CTAI, working with France and the UK, will bring all elements of the system to a Technical Readiness Level (TRL-7) by December 2004.

The UK Ministry of Defence has recently completed its Objective Future Cannon Programme to determine which medium-calibre weapon would be appropriate for new vehicle platforms as well as upgrades of existing platforms. According to CTAI, the findings of this study have been shared and agreed with the French government.

For trials and demonstration purposes the 40mm CTWS was recently installed in the turret of the Alvis Vehicles Warrior (*JDW* 9 March). It is also installed in both examples of the SIKA and Lancer testbeds developed to meet the now cancelled operational requirements of the UK and US armies.

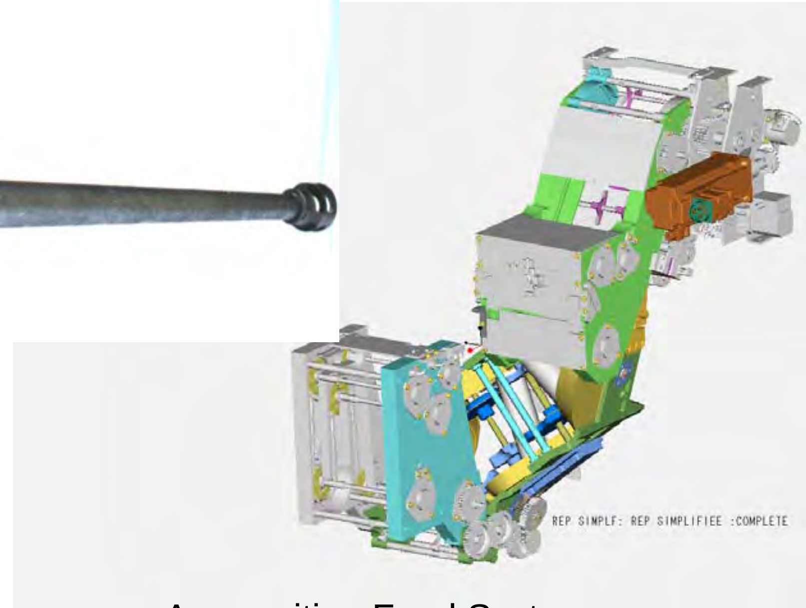
Giat Industries of France and BAE Systems RO Defence of the UK jointly own CTAI, and the two companies have provided all development funding to date as a private venture.

Christopher F Foss
JDW Land Forces Editor, Paris

British Army Warrior IFV armed with a CTAI **40mm Case Telescoped Weapon System**

TRL 7 Definition
‘System technology prototype demo in an operational environment’

Cannon – 40mm CTWS



Ammunition Feed System

Ammunition: APFSDS, GPR-PD, TP-T

‘The System’

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‘The Environment’

‘OFCP’ Approach – UK MoD / French DGA / CTAI

- Define Requirement
  - > Performance
  - > Use – i.e. the 48hr Battlefield Mission
  - > Maintenance and Support
- Define a set of assessment criteria
  - > Safety
  - > Environmental robustness
  - > Reliability
  - > Performance
- Develop test and assessment programme to deliver objective evidence
- Execute the programme

Weapon System - Performance

Requirements

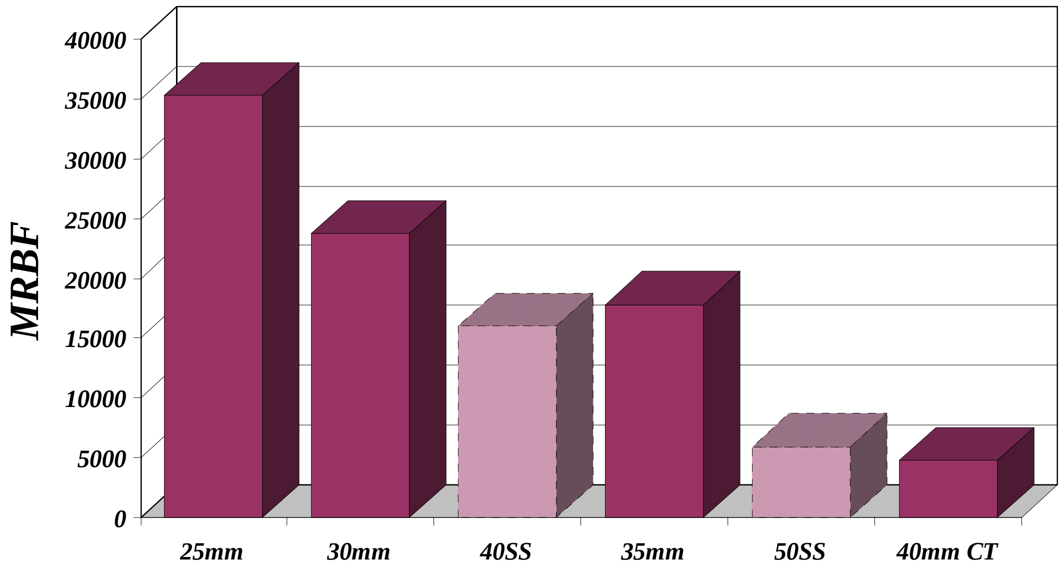
- Rate of Fire 200 Shots per minute
- Fire two ammunition types selectable <3s
- Remote operation
- Low integration volume <80 litres total swept volume
- Dispersion
  - <0,35 mil APFSDS
  - <1 mil GPR
- Minimum Fatigue Safety Life 10,000 rounds
- Operates in safety –46°C to +63°C
- Satisfies prevailing UK MoD and French DGA safety standards
- Reliability >98%
- Supports ‘coincidence’ fire control solution

Before We Talk about Reliability!

Equivalent Stowed Kills

More 'capable' systems need to complete less cycles to complete the mission….. therefore their MRBF requirements are less.

Required MRBF for 98% Reliability Equivalent Stowed Kills



Achieving MRBF costs time, money and adds system level risk!

OFCP - Reliability Test Programme

- Built new weapon
- Used AMSAA model to measure and report reliability
- Complete 10,000 round test programme in all BFM modes

Weapon Safety

- Fatigue Safety Testing
- 30,000 cycles completed on all safety critical components
  - > Barrel
  - > Breech Ring
  - > Recoil system
  - > Chamber
- 3x samples of each component tested in series to destruction
- Cumulative total of 360,000 test cycles completed
- Simulation techniques developed with UK MoD DOSG

Dynamic Pressure Test Rig

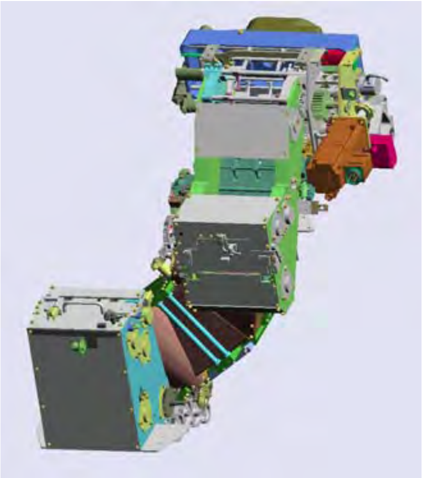
Chamber failed in fatigue

Recoil System Ring stack Failed in Fatigue

Impulse Simulator

Feed System

- Warrior Feed System
  - > Designed
  - > Built
  - > Integrated
  - > Tested
  - > Sept 2002 and Dec 2004.
- Full dynamic vibration test programme completed on full mission load.



CAD Image of OFCP Feed System

Feed System on Vibration Table November 2004

Ammunition TRL Assessment Objectives and Approach

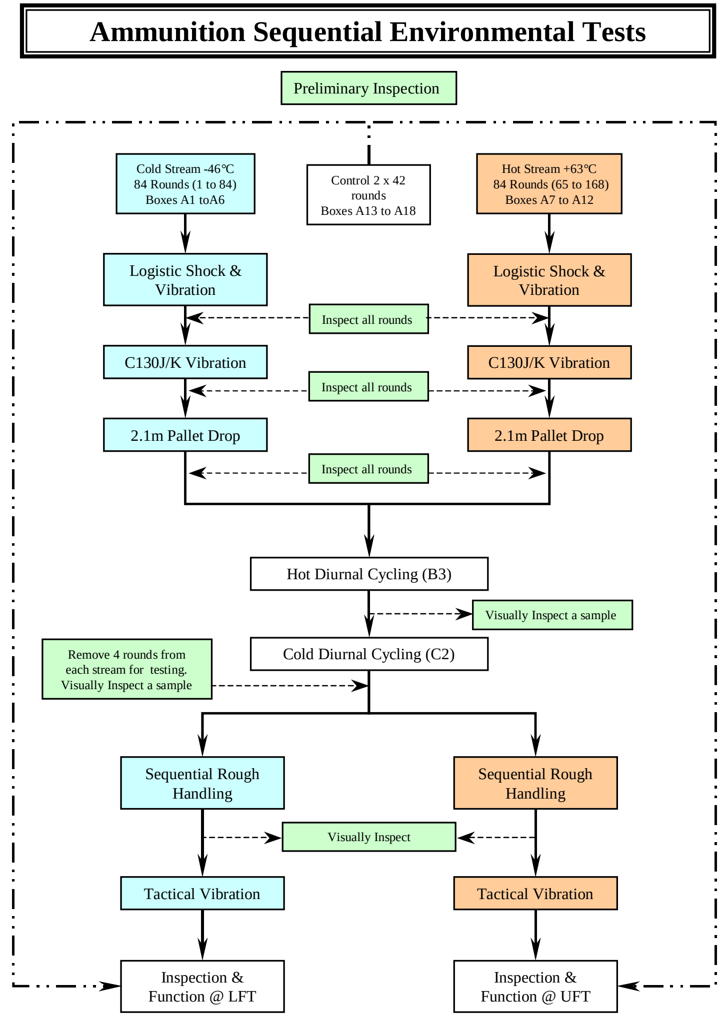
- TRL 7
  - > APFSDS
  - > TP-T
  - > GPR (PD)

APFSDS and TP-T sectioned ammunition

- Freezing of Build Standard
  - > For GPR the development of a Point Detonating fuze
- Production of test Quantities
  - > Nominally 900 rounds of each
- Completion of a sequential environmental test programme
- Completion of IM assessment
- Performance assessment

Environmental Test Programme Completed

- UK MoD DOSG test Programme based OB Proc 43060
- Sequential Environmental Test
  - > Hot Cold Streams –46°C & +63°C
  - > Logistic Shock and Vibration
  - > C130 transport
  - > 2.1m Pallet Drop
  - > Hot Diurnal Cycling
  - > Cold Diurnal Cycling
  - > Sequential Rough Handling
  - > Tactical Vibration
  - > Inspection
  - > Test Firing
- Propelling Charge Evaluation
- Noise / Muzzle Blast
- Projectile Strength of Design
- 12m Drop Test



Ammunition Post Sequential Testing - Looks Ugly

- As always testing was not without some minor problems, but all environmental tests were completed and the firing programme concluded; 100%

Some Deterioration of Packaging

Minor Surface corrosion

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…….but still Shots Great!

GPR PD Firing Oct 2004
From Warrior IFV Turret

Effective Breaching Brick Walls

Defeat of Armoured Concrete with Behind Armour Effects

…while sensitive Against very light targets

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Insensitive Munition (IM) Testing

- Tested to Requirements of STANAG 4439
- Only APFSDS tested to date
- Tests completed
    - > Fuel Fire
    - > Slow heating
    - > Bullet Attack
    - > Sympathetic Reaction
    - > Shaped charge

Before **After**

Sympathetic Packaged

Sympathetic in Feed system Module

Fuel Fire; Type IV reaction

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Airburst TRL 5 Demonstration

- Completed over 200m (closed tunnel firing)
  - > Safe and Arm function confirmed
  - > Point Detonating Function Confirmed
  - > Airburst function confirmed
  - > Last multiple round trial 100% functional

Arena Trials

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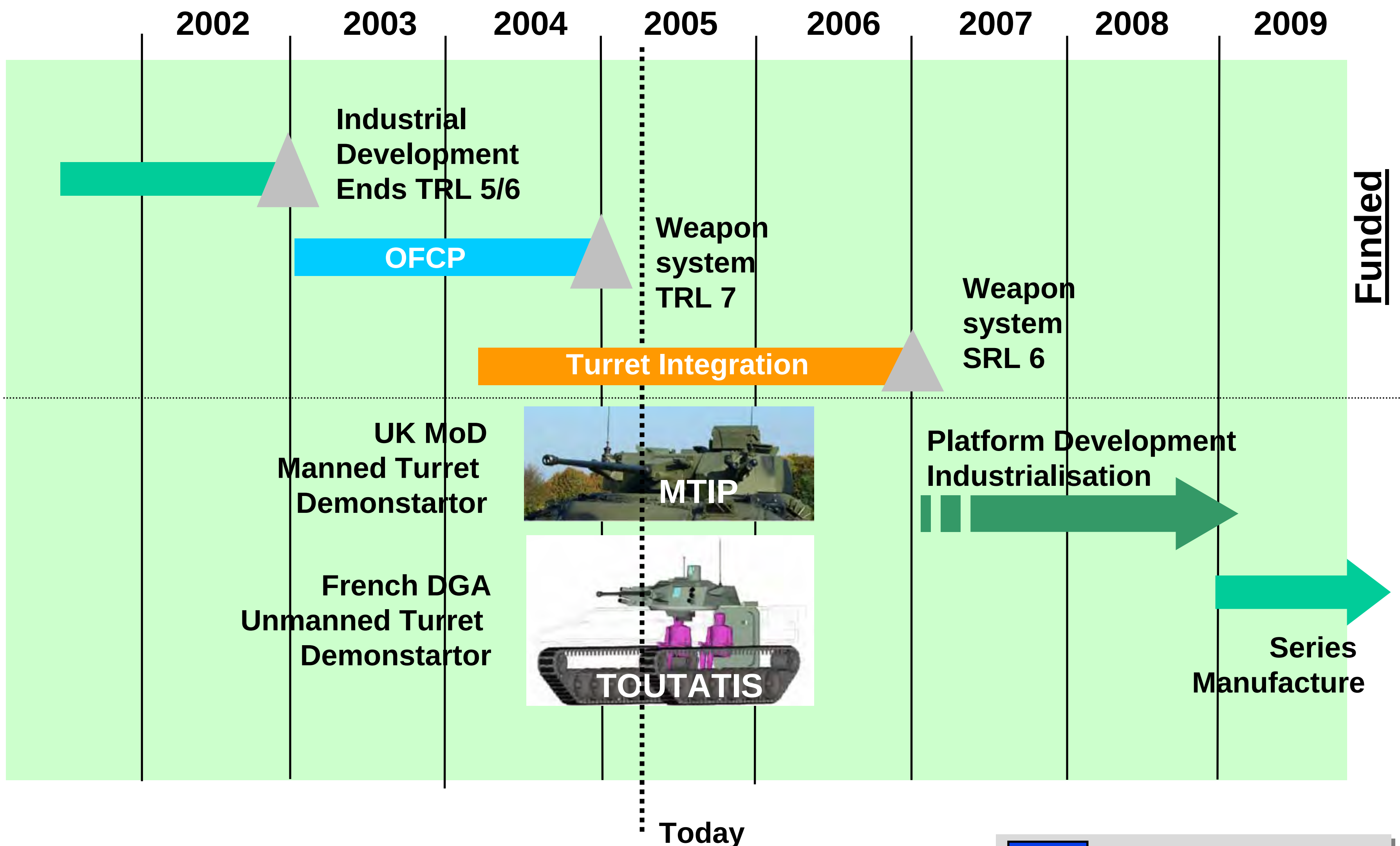
Turret Integration - OFCP assessment

- BAE Systems PV investment provided opportunity to design and build a turret which was used as part of OFCP maturity assessment
- Principal objectives
- Demonstrate physical integration of weapon
- Demonstrate management of CTWS out of balance
- Demonstrate 'User' functionality of Weapon System with confines of turret.
  - > **Loading**
  - > **Unloading**
  - > **Firing**

40mm CTWS Weapon Stabilisation

CTWS Route Map



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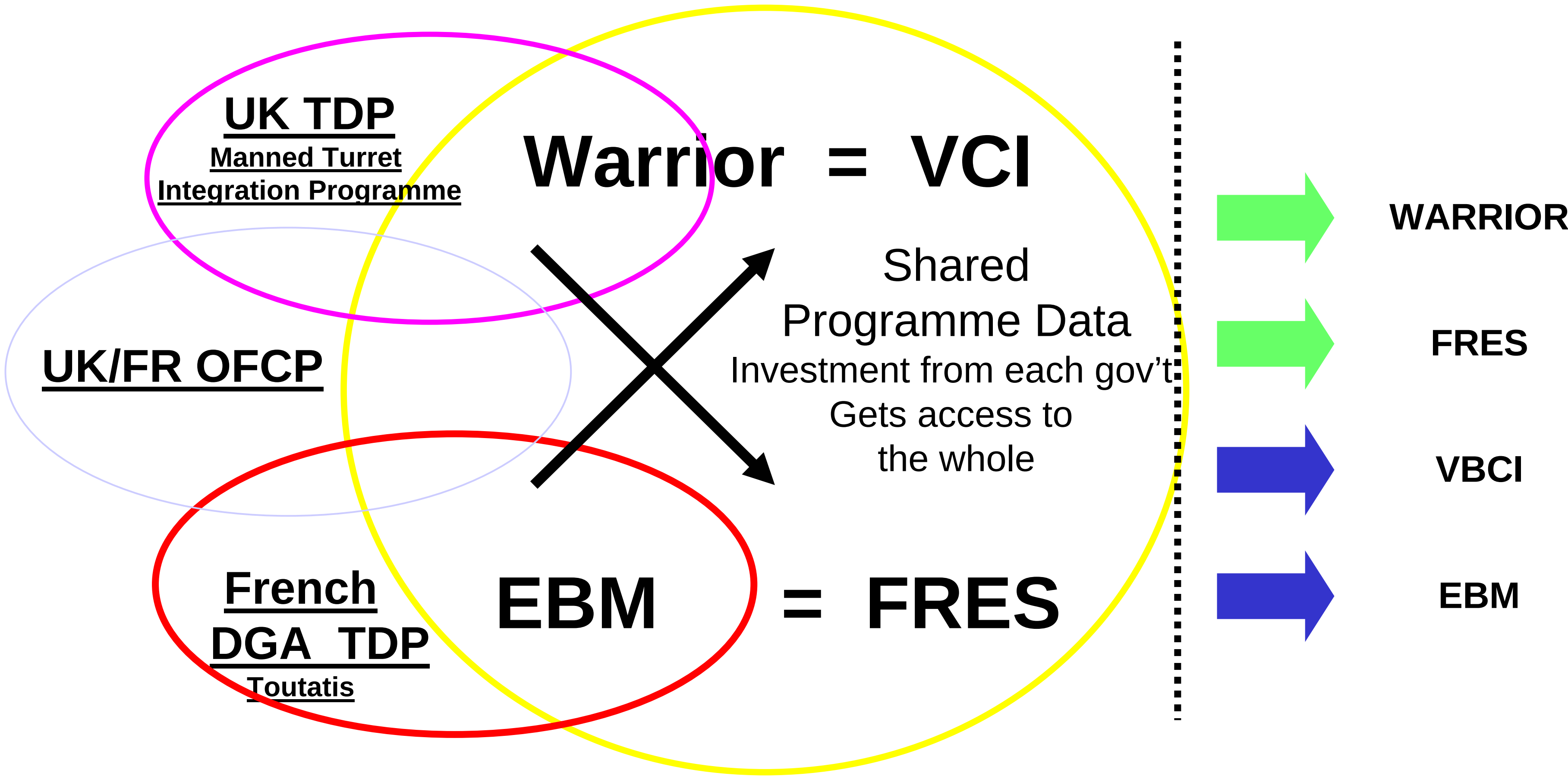
UK and French Government Collaboration



Prototyping and Demonstrator Phase

EMD & PROD'N

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CTAI Turret Demonstrator Programmes

MTIP
4 Tonne Conventional Manned Turret

Toutatis
1,5 Tonne Unmanned Turret

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Manned vs Unmanned

Mechanical Integration Considerations

40mm CTWS Feed system Modularity

MTIP
42 Rounds
2 Natures

VBCI
70 Rounds
2 Natures

Toutatis
68 Rounds
3 Natures

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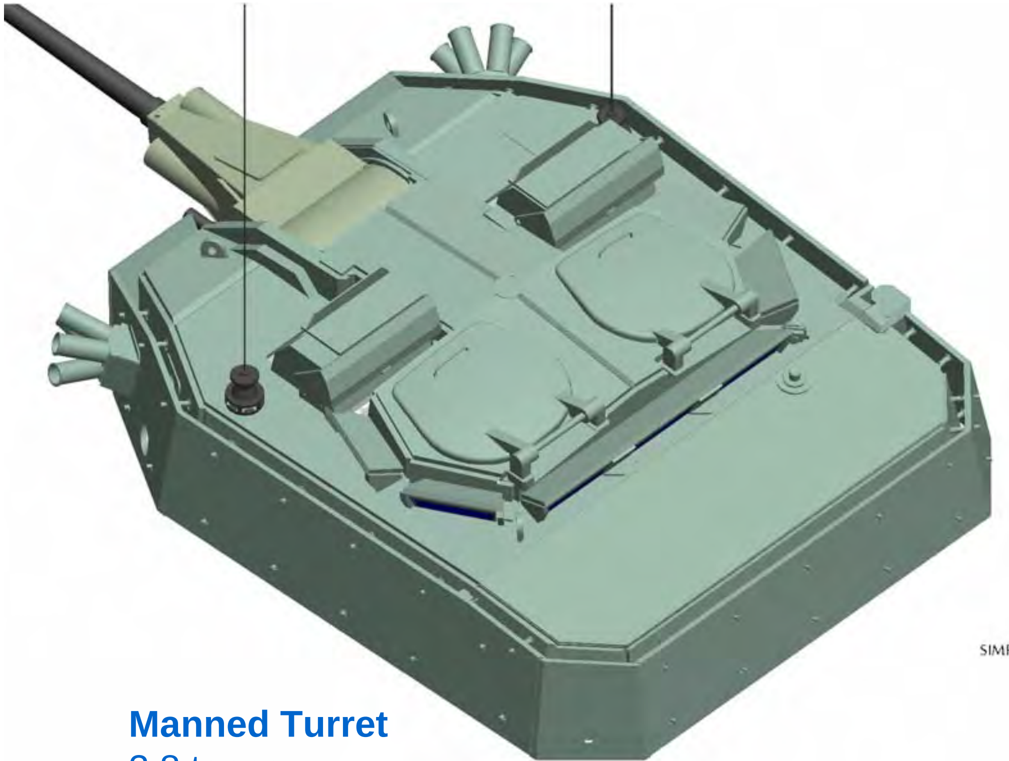
Manned vs Unmanned



Manned Turret
3,8 tonnes
Protection Level 4

Un manned Turret
1,5 tonnes
Protection Level 3

Manned vs Unmanned

Electronic Architecture Considerations

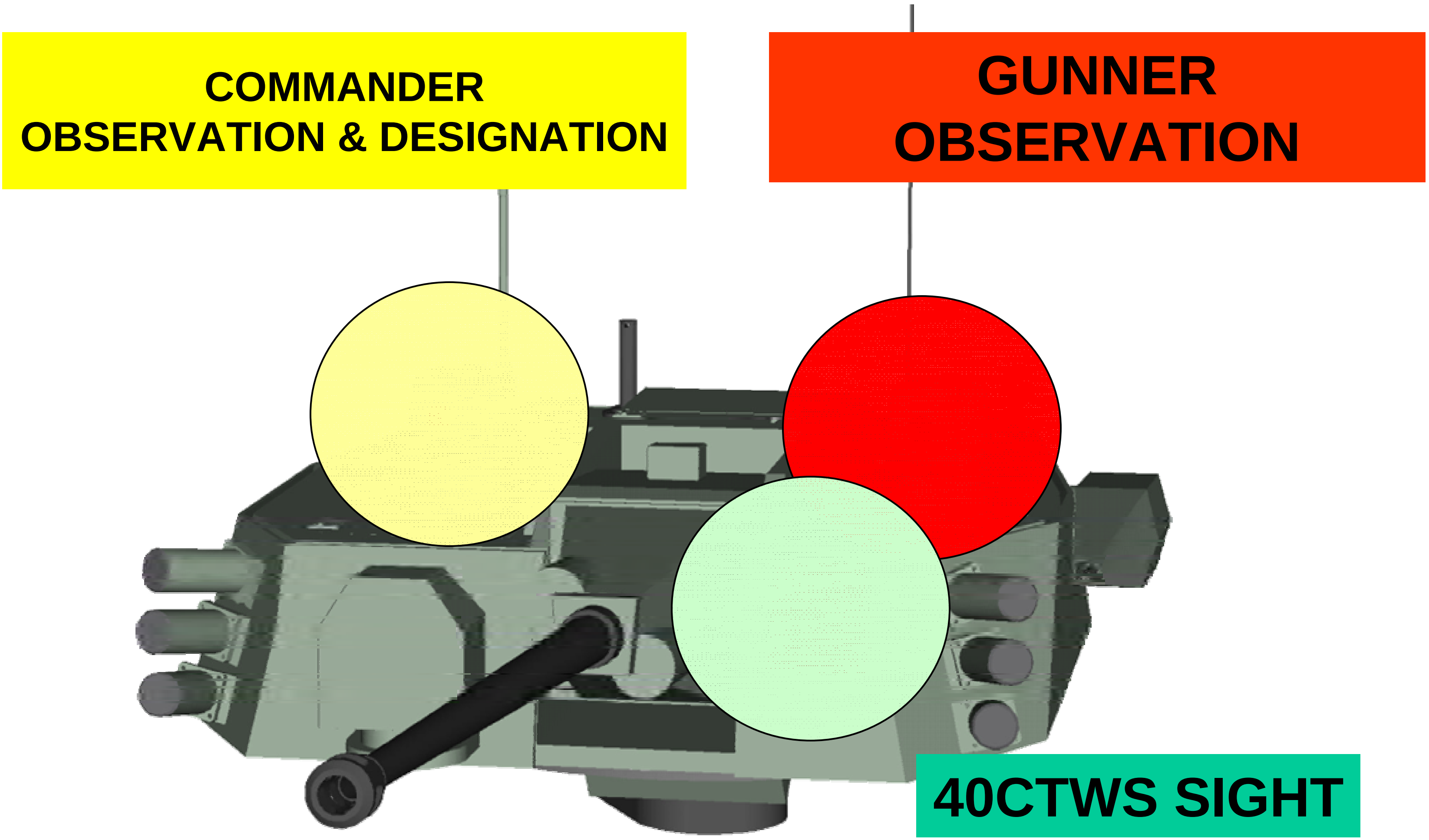
Electronic Architecture Functionality against KUR

KURs (defined by Capability demands)

- FIREPOWER
- SURVIVABILITY
- MOBILITY
- CAPACITY
- C 3
- STA
- SUSTAINABILITY

- Exploit the Data Management System
- Inform the Crew Members
- Operate the Radio Comms
- Command the movements of the Vehicle
- Use the Observation System
- Exploit the Auto-Surveillance Suit
- Exploit the IFF system
- Operate the Fire Function
- Operate the Defense Aids Suit

TOUTATIS SIGHTING SYSTEM : PRODUCT VIEW



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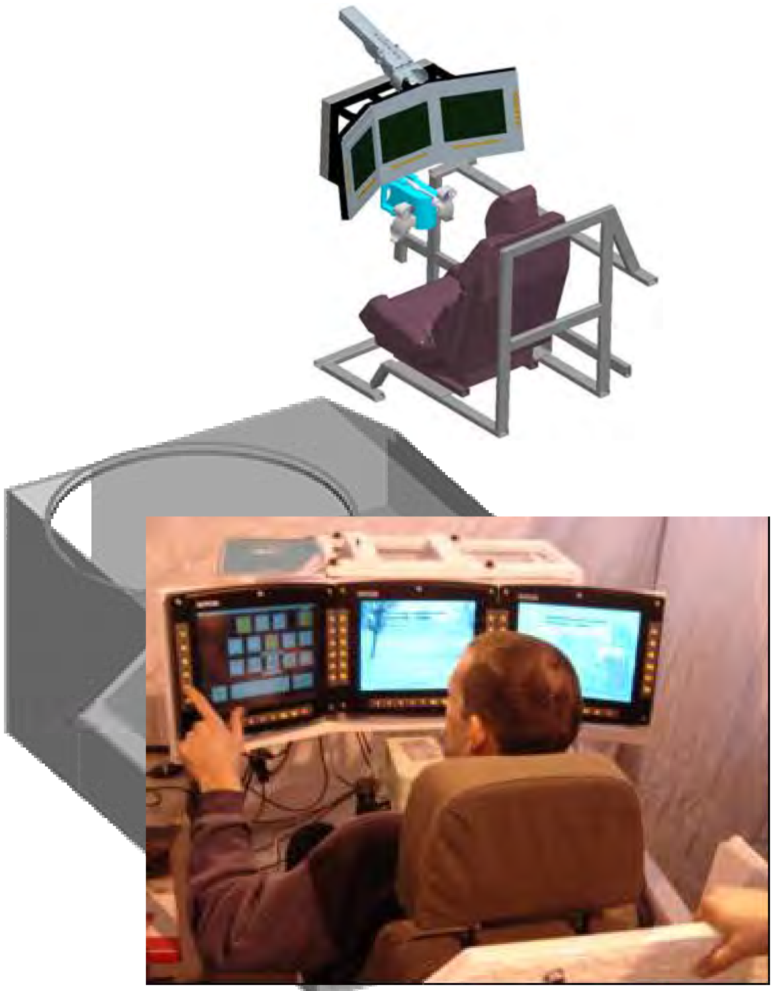
Gunner's Crew station

Unmanned



French Army Leclerc Gunner Operating
Toutatis MMI prototype; Bourges March 2005

Manned

Unmanned solution ultimately demands confidence in Indirect Situational Awareness with a consequential impact on the EA.

Fire Function EA Drivers

Data Network (MILCAN)

- Bandwidth and rate
- Determinism

Video Network

- Sensors
- HD Display / Virtual reality
- Video mixing

Power Network

- Low/High
- EMC
- Autonomy
- Protection

Safety Network

- Technology
- Redundancy

‘Translating Lessons Learned into Systems Requirements’

Black Watch Warriors prepare to advance to set up a Forward Operating Base to the east of the Euphrates

Conclusions

- Highest lethality at lowest system integration burden
- Overmatch provides best insurance against Asymmetric Target Sets for the next 30 years
  - > APFSDS old generation vehicles
  - > GPR Airburst suppression
- CTWS as a weapon system technology is at TRL 7
- 2006 will see Turret Demonstrators (Manned and Unmanned) at SRL 6

CTWS an 'Enabling Technology' for all future medium calibre lethality requirements


Any Questions?
35 KG 14

Propellant Replacement for the 105-mm M67 Propelling Charge

40th Annual Armament Systems: Guns-Ammunition-Rockets-Missiles Conference & Exhibition
April 25-28, 2005

Adriana L. Eng
Sandor Einstein
Donald Chiu

Propulsion Research & Engineering Branch
U.S. Army ARDEC at Picatinny Arsenal

ITEM DESCRIPTION

105mm M1 Cartridge with M67 Propelling Charge

BACKGROUND

- **HAZARDOUS MATERIALS IN M67 CHARGE**
  - ✓**Toxic lead decoppering agent**
  - ✓**M1 propellant ingredients (DNT, DBP, DPA) hazardous to health & environment**

BACKGROUND (CON'T)

- **FOREIGN SOLE SOURCE**
  - ✓ **Dinitrotoluene from a foreign country**
- **PROPELLANT INVENTORY: M1 MP DEPLETED BY FY03; M1 SP BY FY07**

OBJECTIVES

- **Replace hazardous M1 propellant with environmentally compliant PAP7993 propellant**
- **Replace toxic lead decoppering agent with nontoxic decoppering agent**

PROJECT PLAN

- **PROPELLANT IMPROVEMENT**
  - ✓ **Reformulate PAP7993 with**
    - ➢ **More effective stabilizer to reduce propellant out-gassing**
    - ➢ **Nontoxic decoppering agent**
  - ✓ **Preliminary safety/sensitivity, accelerated aging and closed bomb tests**
  - ✓ **Producibility**
    - ➢ **SP webs: 0.011”, 0.014”, 0.017”**
    - ➢ **MP webs: 0.021”, 0.025”, 0.029”**

PROJECT PLAN (CON'T)

- **PROPELLANT IMPROVEMENT (CON'T)**
  - ✓ **Initial ballistic evaluation**
    - ➢ **SP webs: 0.015", 0.017"**
    - ➢ **MP webs: 0.025", 0.029"**
    - ➢ **Charge weight assessments**
    - ➢ **Uniformity at cold, ambient, hot**
    - ➢ **IBHVG2 computer simulation & modeling**

PROJECT PLAN (CON'T)

- **PROPELLANT QUALIFICATION**
  - ✓ **Thermal Stability**
  - ✓ **Impact Sensitivity**
  - ✓ **Friction Sensitivity**
  - ✓ **Shock Sensitivity**
  - ✓ **Electrostatic Sensitivity**
  - ✓ **Fast & Slow Cook-off**
  - ✓ **Material Compatibility**
  - ✓ **Variation of Properties with Age**
  - ✓ **Others**

PROJECT PLAN (CON'T)

- **M67 PROP CHARGE QUALIFICATION**
  - ✓ **Ballistic performance**
    - ➢ **Final SP and MP granulations**
    - ➢ **Charge weight assessment**
    - ➢ **Uniformity at cold, ambient & hot**
  - ✓ **Sequential environmental/rough-handling**
    - ➢ **Vibration, loose cargo, temperature soak, drops, ballistic firings at hot and cold**

PROJECT PLAN (CON'T)

- ✓ **Final hazard classification**
  - ➢ **Confined & unconfined stacks, bonfire, thermal stability, 12-m drop**
- ✓ **Propellant and propellant bags shelf lives**

ACCEPTANCE CRITERIA

- **Propellant to meet Energetic Materials Qualification Board requirements**
- **Muzzle velocity variations equal/better than M1 propellant**
- **Low zone minimum pressure equal/better than M1 at cold temperature**
- **Top zone maximum pressure less than Permissible Individual Maximum Pressure (PIMP)**

ACCEPTANCE CRITERIA (CON'T)

- **Temperature sensitivity comparable to M1**
- **PAP7993 propellant and acrylic bags shelf lives equal/better than those of M1 and acrylic bags**
- **M67 prop charge to pass all safety hazard tests**

ACCOMPLISHMENTS

- **Propellant improvement efforts completed**
- **Successful production of initial propellant lots at RAAP**
- **First ballistic evaluation completed at YPG with satisfactory results**
- **Propellant qualification near completion**
- **Successful production of second propellant lots at RAAP**
- **Potential cost saving by elimination of lead foil**

PLANNED ACTIONS

- Complete propellant qualification
- Complete M67 qualification
- Submit technical reports & Engineering Change Proposal

ACKNOWLEDGEMENTS

- FUNDING
  - ✓Acting Deputy Chief of Staff for Ammunition
  - ✓Office of Project Manager for Combat Ammunition Systems
  - ✓US Army Joint Munitions Command
- ENGINEERING & PROJECT MANAGEMENT
  - ✓US Army Armament Research, Development and Engineering Center at Picatinny (ARDEC)

ACKNOWLEDGEMENTS (CON'T)

- **TESTING**
  - ✓ **US Army Armament Research, Development and Engineering Center at Picatinny**
  - ✓ **US Army Yuma Proving Ground**
  - ✓ **Army Research Laboratory**
  - ✓ **Naval Surface Warfare Center at Indian Head**

ARDEC

AMC

Concepts and Practices in Finding and Applying Lessons Learned

Presented by:
David Fair
General Engineer

NDIA's 40th Annual Armament Systems: Gun - Ammunition - Missiles - Rockets Conference & Exhibition

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

25-28 April 2005

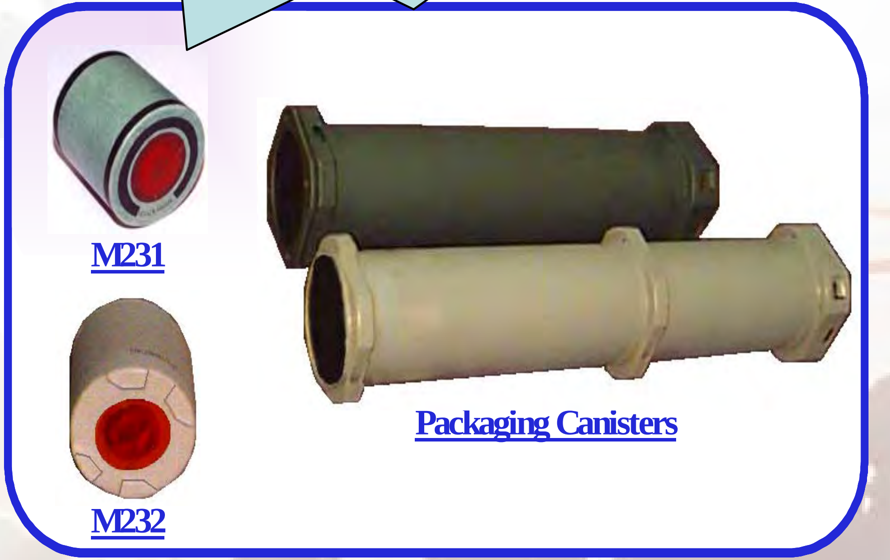
Acknowledgements

- As will most efforts, the difference between a successful and an unsuccessful program is the people involved in the project.
- Applying “Lessons Learned” to a project certainly depends on more than the efforts of one or two people.
- This project was a success only because of the dedication of the Modular Artillery Charge System (MACS) team and their commitment to applying “Lessons Learned” to the MACS program.

Modular Artillery Charge System

- Two charge additive system Crusader
- Compatible with automated loading
- Maintain backward compatibility
- Environmentally compliant
- Meet insensitive munition goals

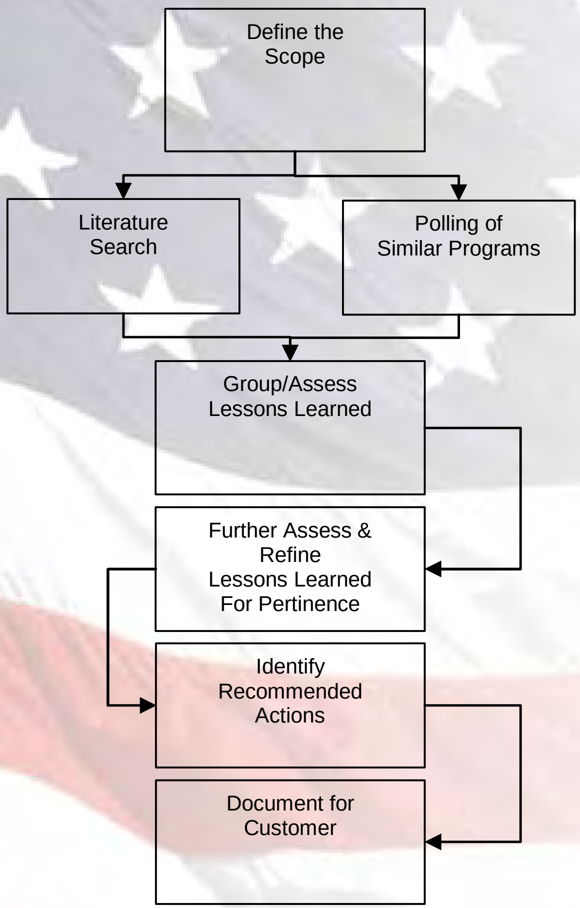
New PM wanted a review of Lessons learned



Little Guidance on Using Lessons Learned

- At the time of the initial study guidance on the use of lessons learned was not well established
  - Used by PM Production Base Modernization to review and update operation manuals
  - Collected and stored in libraries and databases
- Current DoDD 5000.1 guidance, paragraph 4.5.9.3
  - Ideally, a program manager searches lessons learned databases for analogous systems, enabling the program manager to be better prepared to defuse potential problems before they become real problems or to see what solutions to similar problems worked well in the past. However, because lessons learned databases are currently highly decentralized, it is often difficult to efficiently and effectively find applicable lessons learned in a form that is useful.

The Approach



Define the Scope

Literature Search and Polling Similar Programs

Grouping the Information

Assessing and Refining

Identification of Recommended Actions

Documenting

Defining the Scope

- Taylor the scope to the problem
  - We opened the MACS study up to the entire life cycle
    - Looking for unknown unknowns
    - Looking for solutions to known unknowns
  - Broader scopes translate into more lessons learned to review
  - Narrow scopes facilitate computer searches
    - But you may over look some pertinent areas

Searching and Polling for Information

Existing Databases

- Up Side
  - Outside the box
  - Computer searches
  - Claimed validity of results
  - Avoids vested interests
- Down Side
  - Large numbers
    - 1000
  - Translating to your application
  - Focuses on success stories

Polling Analogous Systems

- Up Side
  - Small number (24)
  - Focused to your effort
  - Teaming with peers
    - Things done incorrectly
- Down Side
  - Effect of group thinking
  - Some NIH
  - Exposure to premature criticism

Use both approaches and practice people skills
Some lessons learned will conflict, accept it and adjust
Throw out lessons learned that do not apply

Grouping

- Sort out those that do not apply
- Combine lessons learned into themes
  - Facilitates comparing Lessons Learns
  - Sorting out duplicates
  - Division of work load

Communications (2)
Technical Data Package (6)
Initial Production Facilities (3)
Inspection and Testing (4)

Producibility (28)
Transition to Production & ECPs (7)
Facility Planning (8)
Item Design (4)

Others (30)

Assessing and Refining

- Identify the source program
  - Big differences between programs ammunition, weapon systems, etc.
- Concise statement of lessons learned
  - Abstract of the lessons learned
- Define the application
  - Describe the application to MACS
- List the source and contact

Recommended Action

- Provide a recommended action
  - Evolves from the description of application
  - Concise positive statement
    - Reinforcing - Continue a current activity
    - Investigative
      - Reevaluate something currently being done
      - Look into doing something new
- Identify appropriate action officer by position
- Provide recommended timing

Documenting for the Customer (Reporting to the PM)

- Document the study
  - Subjective in nature
  - Recommendations of a single person or small group
  - Moving target nature of item development
    - Changing information base
    - Changing requirements
    - Product changes and refinements
- Not a published report
  - Needs to be done quickly
  - Needs to understood by all that it is a study

Study Outline

1.0 Introduction

2.0 Methodology

3.0 Summary of Lessons Learned

App A Directly Applicable Lessons Learned (62)

App B Contributed Lessons Learned

App C Other Lessons Learned (30)

Concluding Observations

- Presentation describes a methodology and process
    - Little documentation on “how to use lessons learned”
    - Each situation is unique
    - Avoid cookie cutter approaches
  - Only guidance found “Best Practices Methodology, A New Approach for Improving Government Operations” (GAO/NSIAD-95-154), dated May 1995.

Concluding Observations

- Take a study approach
  - – A study provides alternatives to assist the PM
  - – Do not publishing as a final report
    - Do not imply that findings are definitive and directive
  - – Should facilitate team building
    - If done properly findings will been coordinated with action officers before going to the PM

Concluding Observations

- The process can be applied to other programs
  - Careful scoping at the outset
  - Team approach
  - Avoid short cuts
    - Solicited lessons learned have a higher payback
    - Do not over look the data bases
    - Be prepare to explain why lessons learned apply or do not apply
  - Commitment to open-mindedness throughout the entire process.

Backup

Propellant Charge Weight Assessment of Combustible Cased Tank Ammunition

Program: Cartridge, 120mm, APFSDS-T, M829A1

Lesson Learned: Propellant charge assess of any combustible cased ammunition should contain all the components expected to be utilized in the final cartridge or ammunition lot. Differences in minor components will then be normalized in finial ballistic results.

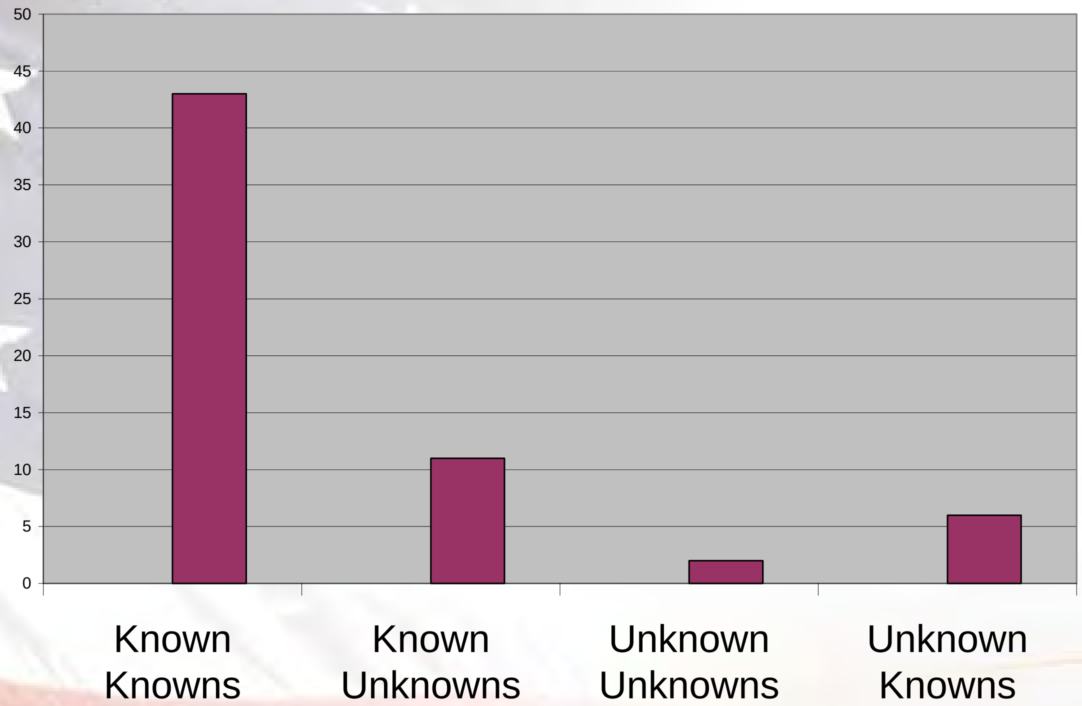
Application: A thorough analysis of mixing combustible components form different lots was performed during the product improvement testing of the M203A1 propelling charge. After significant testing, it was determined that under the current beater additive process the mixing of the combustible case lots during production will have no impact on uniformity. The charge specification currently allows mixing of the case lots for the same interfix number.

Action: This issue was already considered by the developer and no further action is required.

Timing: N/A

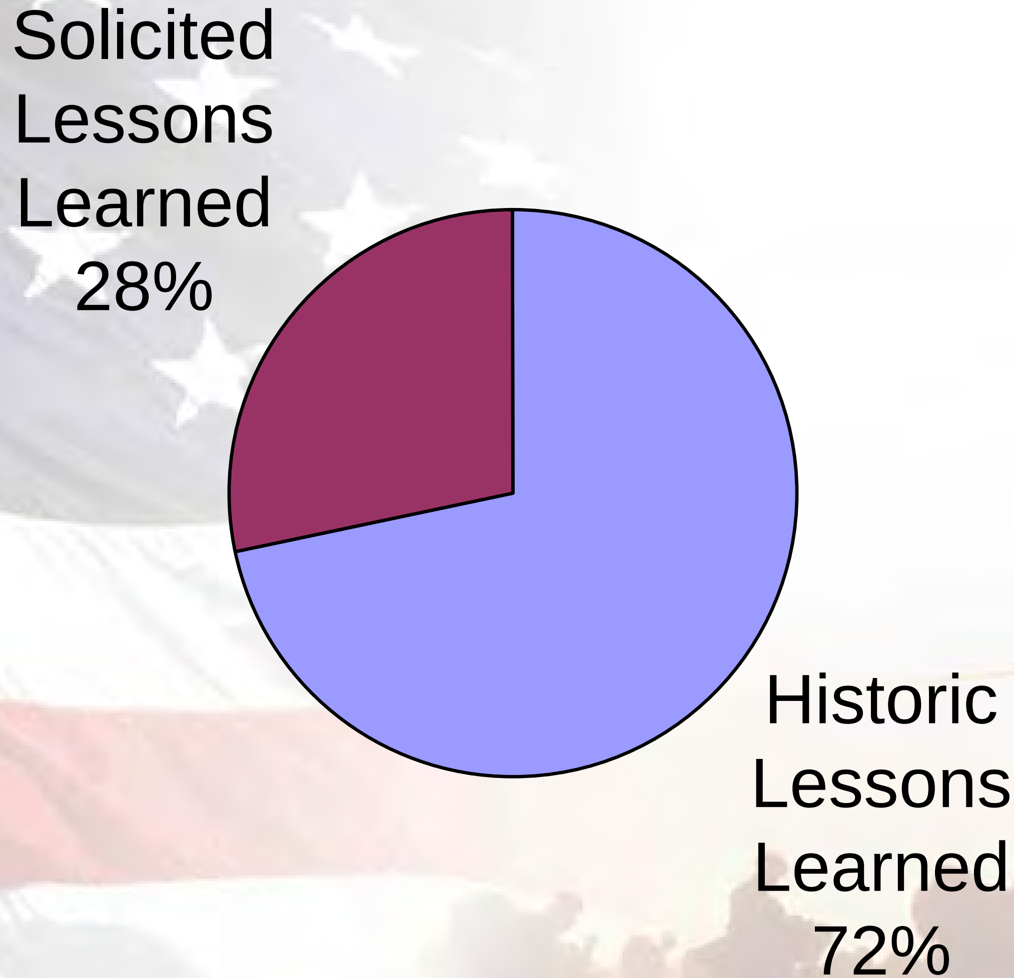
Reference: SFAE-AR-TMA-E, Memo dated 5 March 1992, Subject: Lessons Learned Applicable to the XM230

Post Script
You Never Know How Effective the Effort Was



Known Knows – Policy and practice in place at time of study
Known Unknowns – Planning to address in place at time of study
Unknown Unknowns – Did not plan for prior to study
Unknown Knowns – Did not work out as originally thought

Historic vs. Solicited Lessons Learned Used



GENERAL DYNAMICS
Armament and Technical Products

Mini-Typhoon Remote Operated Small Arms Mount (ROSAM)

Ben Hardie

April 27, 2005

Mount Heritage

- GR Dynamics marketing Mini-Typhoon in the U.S.
  - RAFAEL Development Ltd, Israel
  - General Dynamics Armament & Technical Products, U.S.A.
- Mini-Typhoon remote stabilized gun mount for naval applications
  - Derivative of the Typhoon medium caliber gun mount
  - Developed by RAFAEL in Israel
  - Delivered to multiple foreign navies
- Mini-Typhoon selected as the stabilized mount of choice for U.S. Navy based on performance and price

Current U.S. Application

- U.S. Special Operations Command (USSOCOM)
  - 7 & 11 meter Rigid Hull Inflatable Boat (RHIB)
  - MK V Patrol Boat

System Architecture

System Attributes

- Stabilized, 2-axis mount, n x 360 degree traverse, -20 to +60 degree elevation range
- Lightweight: less than 250 lbs
- Marinized and ruggedized for demanding USSOCOM applications
- Crew serviceable in case of electrical failure
- Integrated fire control computer
- Sophisticated auto tracking capability
- Navy standard power, mounting, and communications interfaces

Performance

- MK III Patrol Boat (20m) fire testing at Pax River
  - Multiple closing, fading, and crossing scenarios
  - Target range 400 meters to 1200 meters
  - Sea State 2-3
  - Probability of hit for crew served M2: **2%**
  - Probability of hit for ROSAM with M2: **35%**
- Large ship (6000 tons) sea trials for Australian Navy
  - Multiple closing, fading, and crossing scenarios
  - Target range 500 meters to 1200 meters
  - Probability of hit for ROSAM with M2: **40-70%**

Flexibility – Detection & Lethality

- Current Sighting System
  - CCD Camera with continuous 10x zoom
  - Fixed field of view uncooled microbolometer infrared camera
- Current weapon selection
  - M2HB 0.50 caliber machine gun
  - MK 19 40mm automatic grenade launcher
  - GAU-17 7.62mm minigun
  - M240 7.62mm machine gun
- Future sighting possibilities
  - Daytime camera with greater detection range
  - Continuous zoom extended range Forward Looking IR camera
- Future weapon possibilities
  - MK 47 40mm automatic lightweight grenade launcher
  - GAU-19 0.50 caliber gatling gun
  - Missiles

Flexibility – Command and Control

- Integrated Bridge System
  - All mount functionality passed to user developed interface
  - Auto tracking and ballistic calculations retained by ROSAM
  - Standard communication protocol (RS-422)
- Advantages
  - Integrator defined control station
  - ROSAM can be slaved to an Electro Optical Director
  - Local control always available

Program Status

- USSOCOM has a 100 mount IDIQ contract through NSWC Crane
  - 14 mounts delivered
  - Mounts undergoing environmental qualification
  - WSESRB approval expected May 2005
  - User evaluations scheduled for June 2005
- Demonstrations using Integrated Bridge System interface
  - SPARTAN unmanned boat April 2005
  - Army Theater Support Vessel May 2005

Shipboard Protection System (SPS)

- Mini-Typhoon the lethality solution for SPS
  - Supports force protection and anti-terrorism efforts for destroyers in port
  - Level of integration dependent on SPS winner
    - RFP down select May 2005
  - Minimum of two units per ship

GENERAL DYNAMICS
Armament and Technical Products

Questions?

APKWS

Block II Demonstration Program

2005 NDIA
Missiles & Rockets Symposium
25-28 April 2005

AMRDEC
Strength Through Technology
Aviation & Missile RD&E Center

ARM
Aviation Rockets and Missiles

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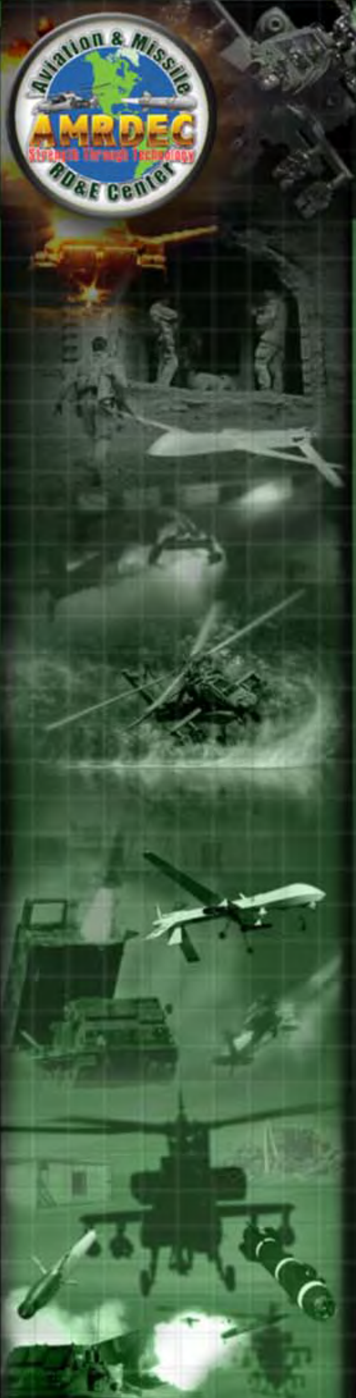
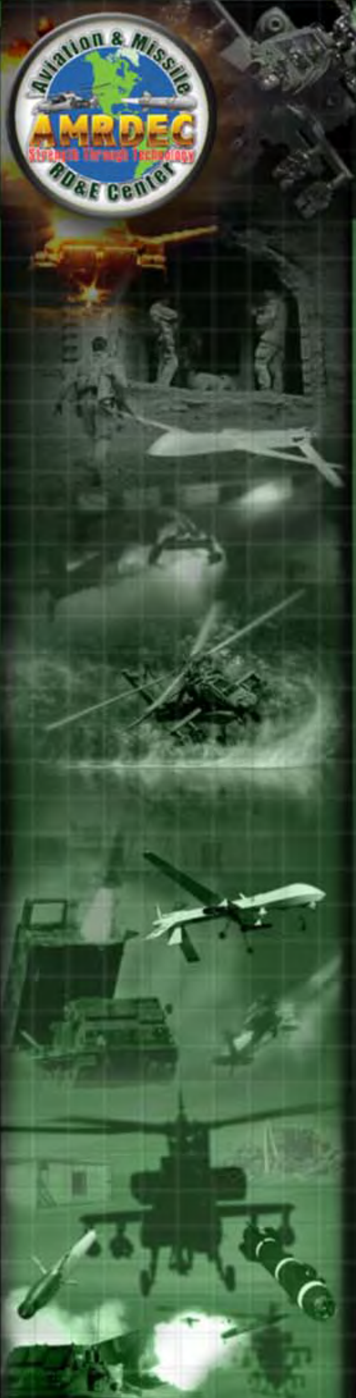


Outline

- Current M151/M423 Performance & Deficiencies
- APKWS Warhead & Fuze Development Program
  - Technology Objectives
  - Key Performance Parameters
  - Target Set
  - Exit Criteria
- Risk Reduction Activities
- Summary



M151 Warhead / M423 Fuze Characteristics

- Insensitive Munitions (IM) Performance
  - Bullet Impact: Deflagration
  - Fragment Impact: Detonation
  - Slow Cook Off: Detonation
  - Fast Cook Off: Detonation
- Naturally Fragmenting Case
  - Produces ~7500 fragments
  - Majority of Fragments are 0-1 grain
  - Limited Fragment Distribution Pattern
- Limited Target Set
- M423 Fuze
  - Single Safety (non MIL-STD-1316 Compliant)
  - Single Mode (Point Detonating)

APKWS Block II Program Overview

System Input

Warhead Input

Fuze Input

Exit Criteria

FY04

Contract Awards (2)

Government Screening Tests to Focus Research

FY04: *Phase I*

Requirements & Design

- Define and Prioritize Targets
- Contractors Demonstrate an Understanding of Requirements
- Preliminary Design Review

FY04: *Phase II*

Proof of Concept

- Testing of Warhead Concept(s)
- Testing of Fuze Concept(s)
- Critical Design Review

FY05: *Phase III*

Design Maturation & Demo

- Integrate Warhead & Fuze
- Perform IM Screening
- Perform Preliminary Environmental Tests
- Perform Dynamic Demonstration

- Follows Successful LCPK ATD Model for Transitioning Technology
- Multiple Contracts
- Must Meet Exit Criteria at End of Each Phase

Proposed APKWS Block II Objectives

Integrate Technologies to Replace the Current M151 and M423

- Main Focus: Insensitive Munition Compliance
  - Improved MIL-STD-1316 Compliant Fuze
  - Improved Warhead and Fuze Performance
- Program Ends in FY05 with TRL 6 Prototype Designs and Supporting Test Data
- Low Risk Transition to APKWS Block II SDD

Expanded Target Set

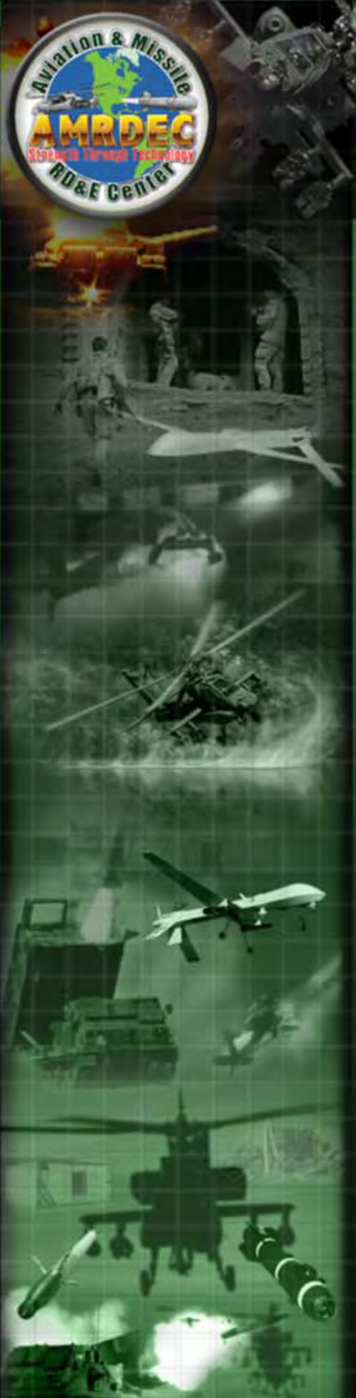
MOUT / Non-Hardened Field Structures

MANPADS

Truck

IFV

UNCLASSIFIED



APKWS Key Performance Parameters

Insensitive Munitions

- MIL-STD-2105B
  - Bullet Impact
  - Fragment Impact
  - FCO (Fast Cook-Off)
  - SCO (Slow Cook Off)

Fuze

- MIL-STD-1316 Compliant
- Multi-mode

Lethality

- MANPADS
- BMP-2 IFV
- Trucks
- MOUT
  - E&T Bunker
  - Brick over Block

Geometry

- Initial Warhead ICD to Be Maintained as M151
- Weight and CG Limits Are TBD by AMRDEC
  - Wind Tunnel Tests to Determine Growth Options

Cost

- Warhead and Fuze DTUPC Less Than $1,500
- Lower Is Better

Contractor Teams

GENERAL DYNAMICS
Ordnance and Tactical Systems
St. Petersburg, Florida

GENERAL DYNAMICS
Ordnance and Tactical Systems
Niceville, Florida

NAVSEA
WARFARE CENTERS

Warhead Development

Action

Fuze Development

ATK
ALLIANT TECHSYSTEMS

Warhead and Fuze Development

Exit Criteria

1. Insensitive Munitions (IM) Compliance
2. MIL-STD-1316 Fuze Safety Compliance
3. Lethality Considerations
4. Length, Weight, and CG Requirements
5. Compatible with Current Rocket & Launcher Interface
   - Must Support Guided and Unguided Configurations
   - Assumes a Front Mounted Warhead on Guided Round
6. AUPC under $1500
7. Low Technical Risk

APKWS Block II Inch-stones

- Contract Award, Mar 2004
- AFSRB Preliminary Review, Jun 2004
- PDR/Completion of Phase I, Jun 2004
- In-Process Review (IPR) #1, Oct 2005
- IM Board Review, Sept 2004
- AFSRB Status Review, Dec 2004
- CDR/Completion of Phase II, Feb & Apr 2005

APKWS Block II Warhead Test Efforts

Insensitive Munitions

- Bullet Impact
- Fragment Impact
- ✓ Fast Cook Off
- Slow Cook Off

Performance Tests

- ✓ Arena
- Water Capture

Penetration Tests

- Earth & Timber Bunker
- Brick Over Block

APKWS Block II Fuze Test Efforts

- ✓ Explosive Train Reliability/Component Output
- ✓ Out-of-Line Safety
- ✓ Progressive Arm
- ✓ Subverted Safety (Jolt, Jumble 1.5 m drop)
- ✓ Performance
  - 1st & 2nd Safety Features
  - Target Detection
- Limited Environmental
- Target Detection Sensor and Warhead Integration

APKWS Warhead / Fuze Program Summary

- Design for IM
- Enhanced Fragmentation
- Enhanced Blast
- Dual Safe, Multi-mode Fuze

Next Step: **APKWS Block II Warhead and Fuze Program Will Provide the Capability to Defeat the Current and Evolving Threat**

Lead Azide Replacement Program
NDIA
Fuze Conference
April, 2005

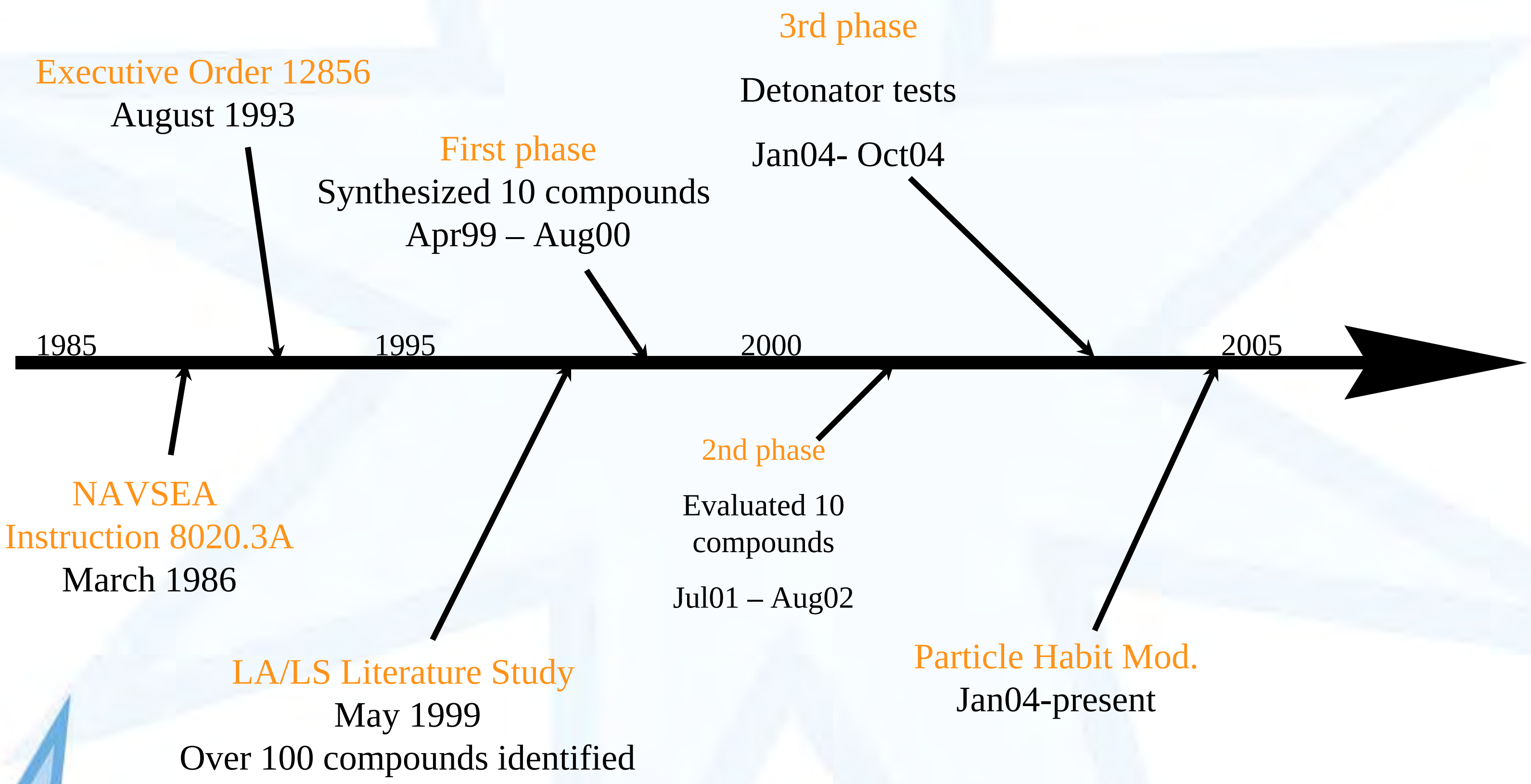
John Hirlinger – U.S. Army ARDEC (973) 724-6498
Magdy Bichay – NSWC-IH (301) 744-2359

John Fronabarger
Mike Williams
Kelly Armstrong
Randall J. Cramer

BACKGROUND

- *Regulatory Drivers:*
  - *NAVSEA Ins. 8020.3A (1986)- Limiting use of Lead azide in Navy ordinance for safety purposes – formation of copper azide in situ.*
  - *Executive Order 12856 (1993)- Series of executive orders issued to reduce/eliminate procurement of hazardous substances and chemicals by federal facilities.*
  - *EPA -Strict regulations regarding the use of lead and other heavy metals*
- *Program initiated by NAVAIR PMA 201 to replace hazardous material used in the CAD/PAD procurement*
- *Supplemental effort funded by the SERDP office to synthesize (using existing process) and evaluate de-sensitized silver azide*
- *No U.S. Manufacturer of Lead Azide*

PROGRAM TIME LINE



Synthesis/evaluation process

- *Typical process for a replacement compound evaluation*
  - *Identify Compound as a primary explosive*
  - *Predict detonation properties and computer modeling*
  - *Develop Synthesis method*
  - *Evaluate Compound*
    - *Phase I Testing – Properties*
    - *Phase II Testing – Performance*
    - *Evaluate test results, make recommendations for follow-on development*

Synthesis/evaluation process Cont'd

Phase I Testing

- *Impact Sensitivity - Ball Drop Method*
- *Friction Sensitivity – Small BAM – 2075g maximum applied load*
- *Differential Scanning Calorimetry (DSC) - 20°C/min, hermetically sealed Al pans*
- *Solubility in water*
- *Theoretical Maximum Density – Helium Pycnometry*
- *Scanning Electron Microscopy – Particle Habit*

Phase II Testing

- *Strong Ignition – witness plate for explosive output – all viable materials at 10 kpsi loading pressure*
- *Variable Loading Strong Ignition – Best Performer from 10K test*
- *M59 Detonator Testing – Best Performer from Strong Ignition Testing*

Strong Confinement Test Results at 10.0 Kpsi Loading Pressure

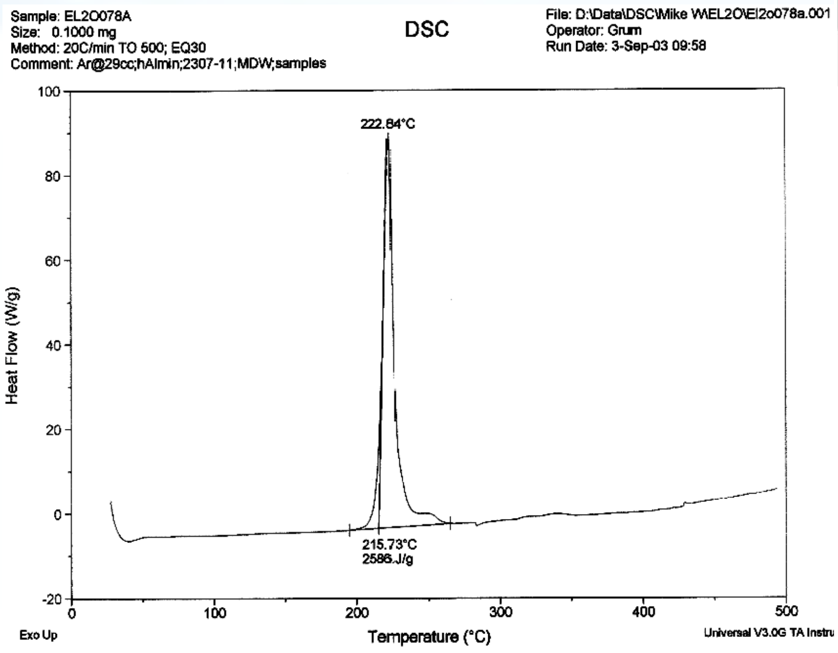
Candidate	Description	Average Charge Density (g/cm^3)	Average Dent (mils)
2A	Trans-tetraamminediazidocobalt(III) perchlorate	1.510	19.1
13A	Copper(II) 5-nitrotetrazole	1.440	13.2
15A	Bis-furoxano-nitrophenol (KBFNP)	1.626	0.8
17A	3-Azido-5-nitro-[1,2,4]triazole, copper complex (dry)	1.421	2.3
19A	Diazido-nitramino-s-triazine, Rb	1.810	0.8
19A	Diazido-nitramino-s-triazine, Cs	2.026	0.5
28A	1,5 Diaminotetrazole, Fe(II) perchlorate complex	1.465	27.0
28A	1,5 Diaminotetrazole, Cu(II) perchlorate comp	1.412	16.8
29A	DAATO 3.5	1.203	0.0
30A	ENTA	1.756	1.3
LA	Lead Azide, RD1333, LN 40148	3.119	37.3

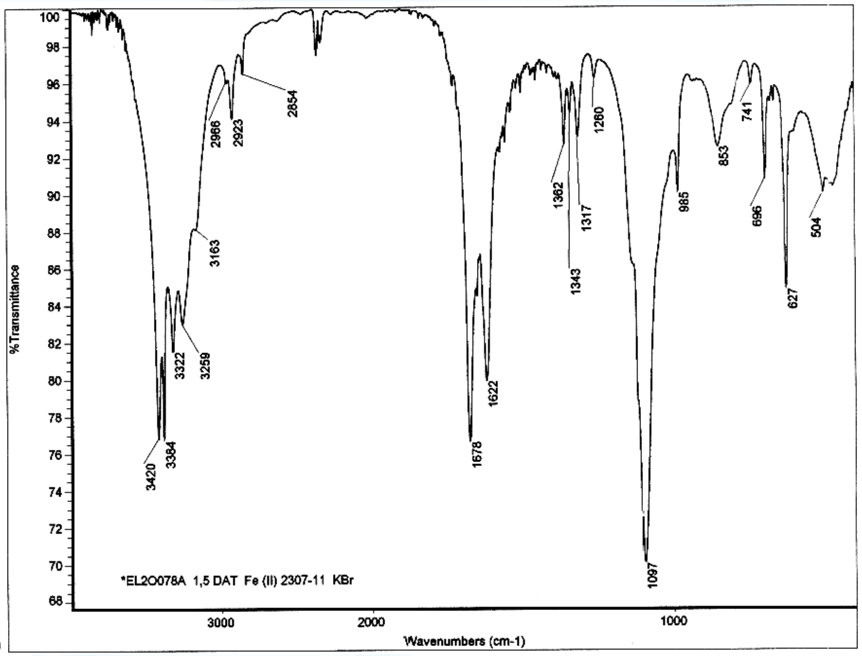
Lead Azide Candidates

- Three Compounds selected for further development/ evaluation
  - 1,5-Diaminotetrazole, Fe complex (28A)
  - Copper(II) 5-nitrotetrazole (13A)
  - Trans-tetraamminediazido-cobalt(III) perchlorate (2 A)

28A, 1,5 Diaminotetrazole, Fe(II) perchlorate complex

28A, 1,5 Diaminotetrazole, Fe(II) perchlorate complex

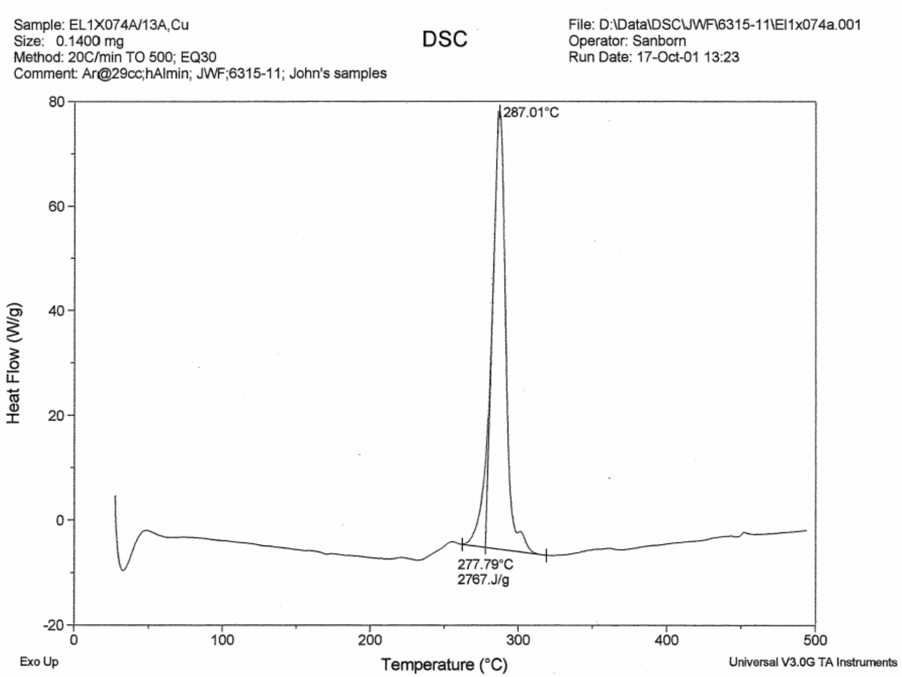


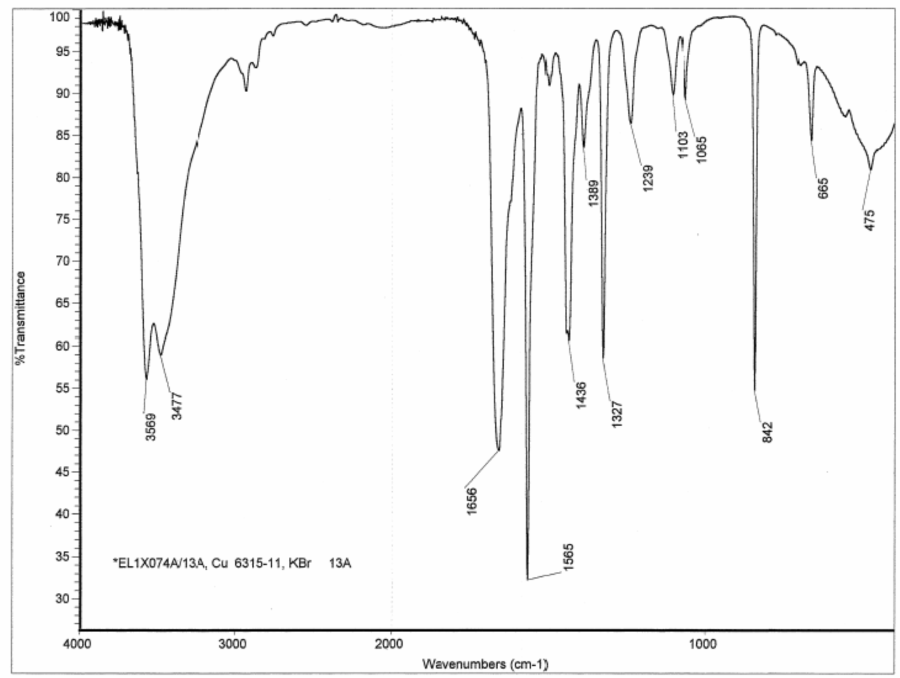


216ºC, 223ºC peak

13A, Copper(II) 5-nitrotetrazole

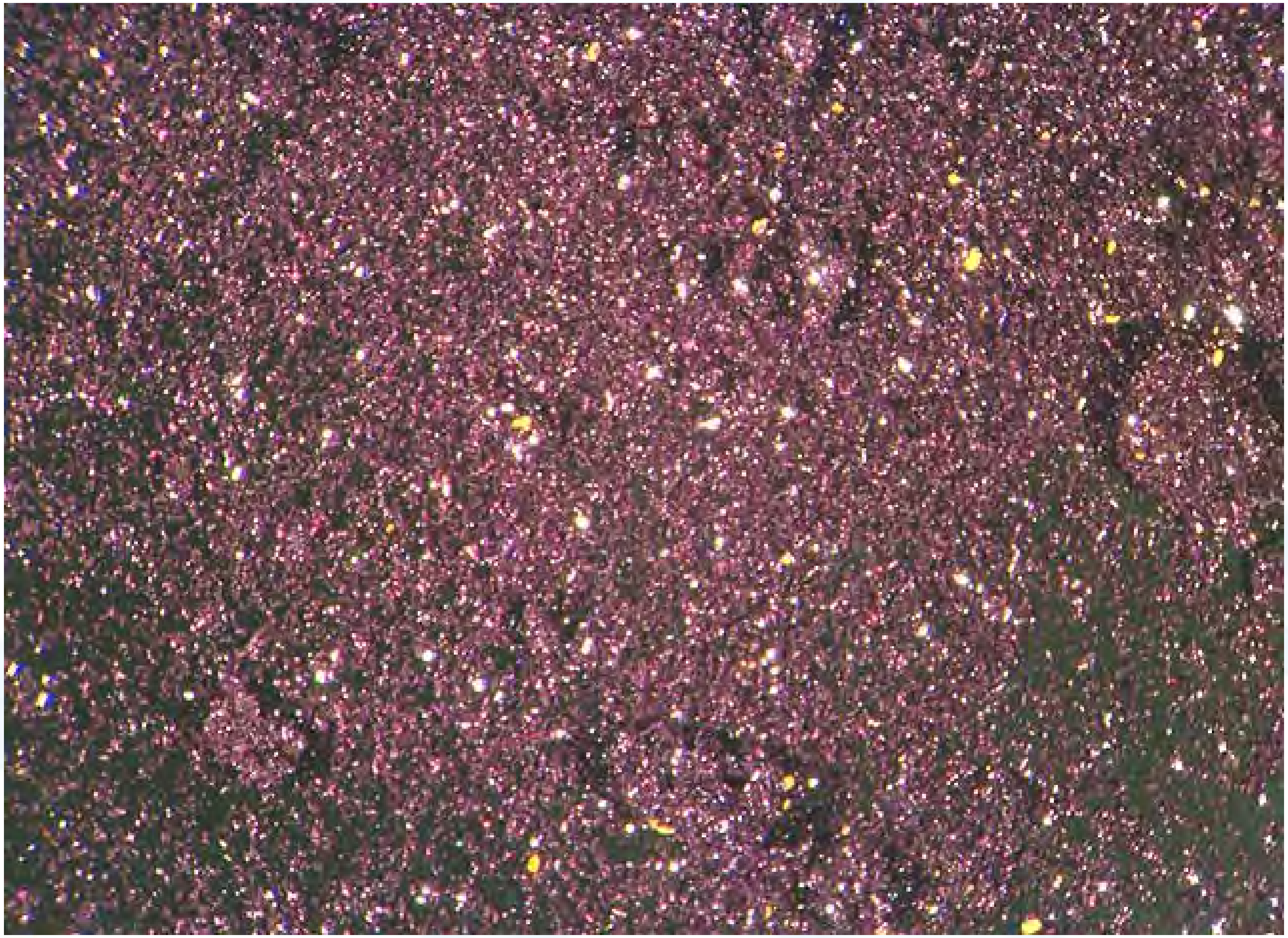
13A, Copper(II) 5-nitrotetrazole





278ºC, 287ºC peak

2A, Trans-tetraamminediazido-cobalt(III) perchlorate



2A, Trans-tetraamminediazido-cobalt(III) perchlorate

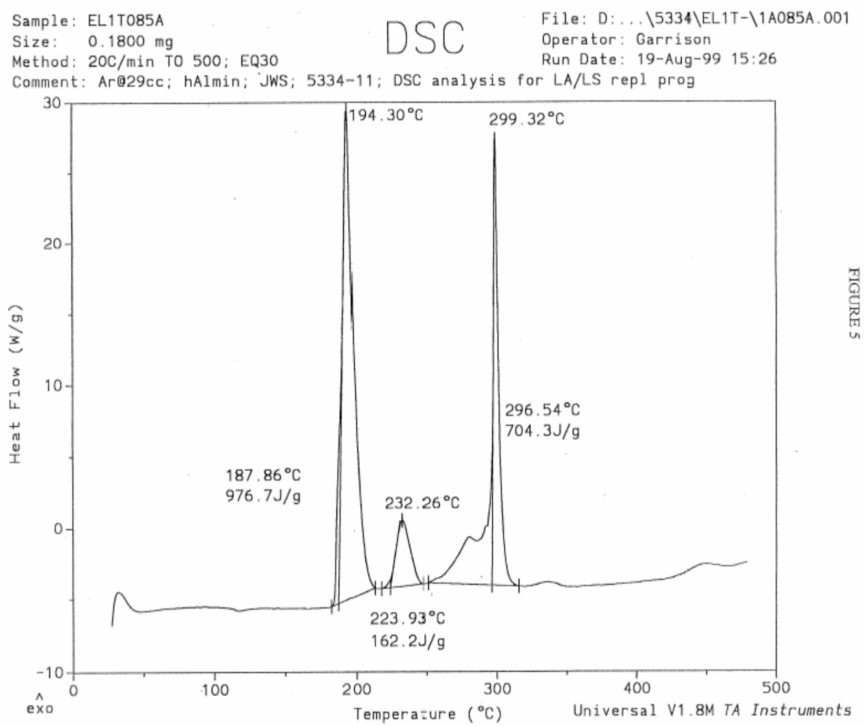
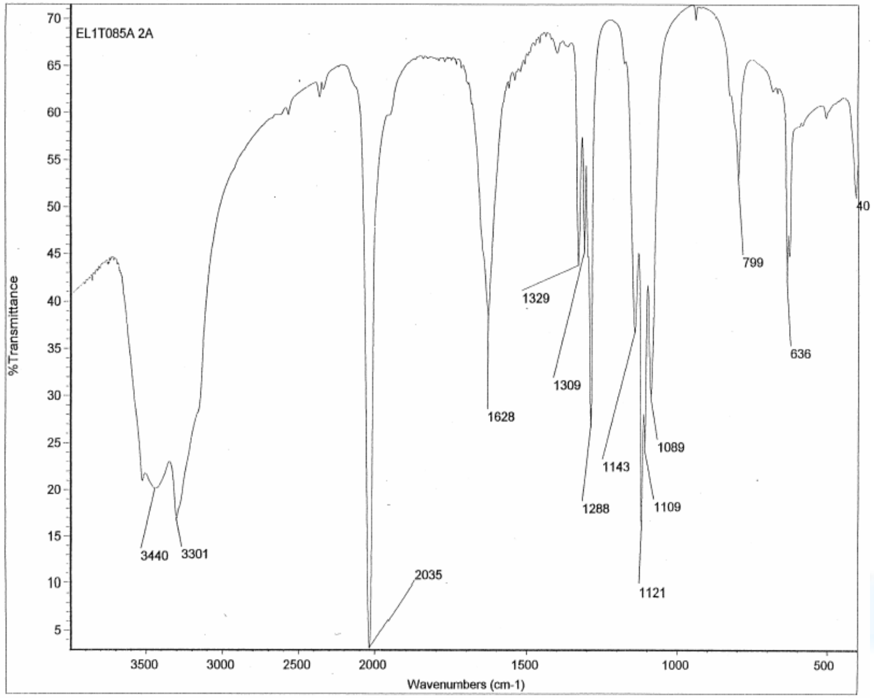


FIGURE 5



Strong Ignition Test Results

CODE	CANDIDATE	LOADING PRESSURE (kpsi)	AVERAGE CHARGE DENSITY (g/cm^3)	AVERAGE DENT IN Al BLOCK (mils)
2A	Trans-tetraamminediazido-cobalt(III) perchlorate	5 10 20 40	1.33 1.44 1.60 1.84	19.6 31.1 29.3 21.7
$13A_1$	Copper(II) 5-nitrotetrazole	5 10 20 40	1.26 1.38 1.53 1.77	9.0 22.6 31.7 29.0
28A	1,5-Diaminotetrazole Fe(II) Perchlorate complex	5 10 20 40	1.18 1.33 1.52 1.62	35.3 40.3 37.7 23.3
	RD1333 LA	5 10 20 40	2.87 3.17 3.60 3.98	30.5 34.0 36.9 39.4

Tabulated Properties of Costain Process Silver Azide

Property	Costain Process Lot 8702	Costain Process Lot 8703	RD1333 Lead Azide
Bulk Density g/cc:	1.6	1.6	1.3
Granulation:			
%On 100	18	17	1
On 140	27	32	5
On 200	33	24	14
On 325	18	22	42
Thru 325	4	5	38
Assay:	99+%	99+%	97-98%
Hygroscopicity:	Nil	Nil	Very Slight
Vacuum Stability:			
1g/40 hrs/150°C	0.49	0.34	0.40
Impact Sensitivity			
P.A. 10% Point:	11 in	7 in	7 in
50% Point	17 in	10 in	8 in
Ball Drop 10%:	11 in	10 in.	10 in.
Electrostatic Sensitivity:	.0094 Joules	.018 Joules	.0005 Joules

T. Costain, "A New Method for Making Silver Azide", Technical Report 4595, Picatinny Arsenal, Dover, N.J., Feb. 1974; U.S. Patent 3,943,235 (1976)

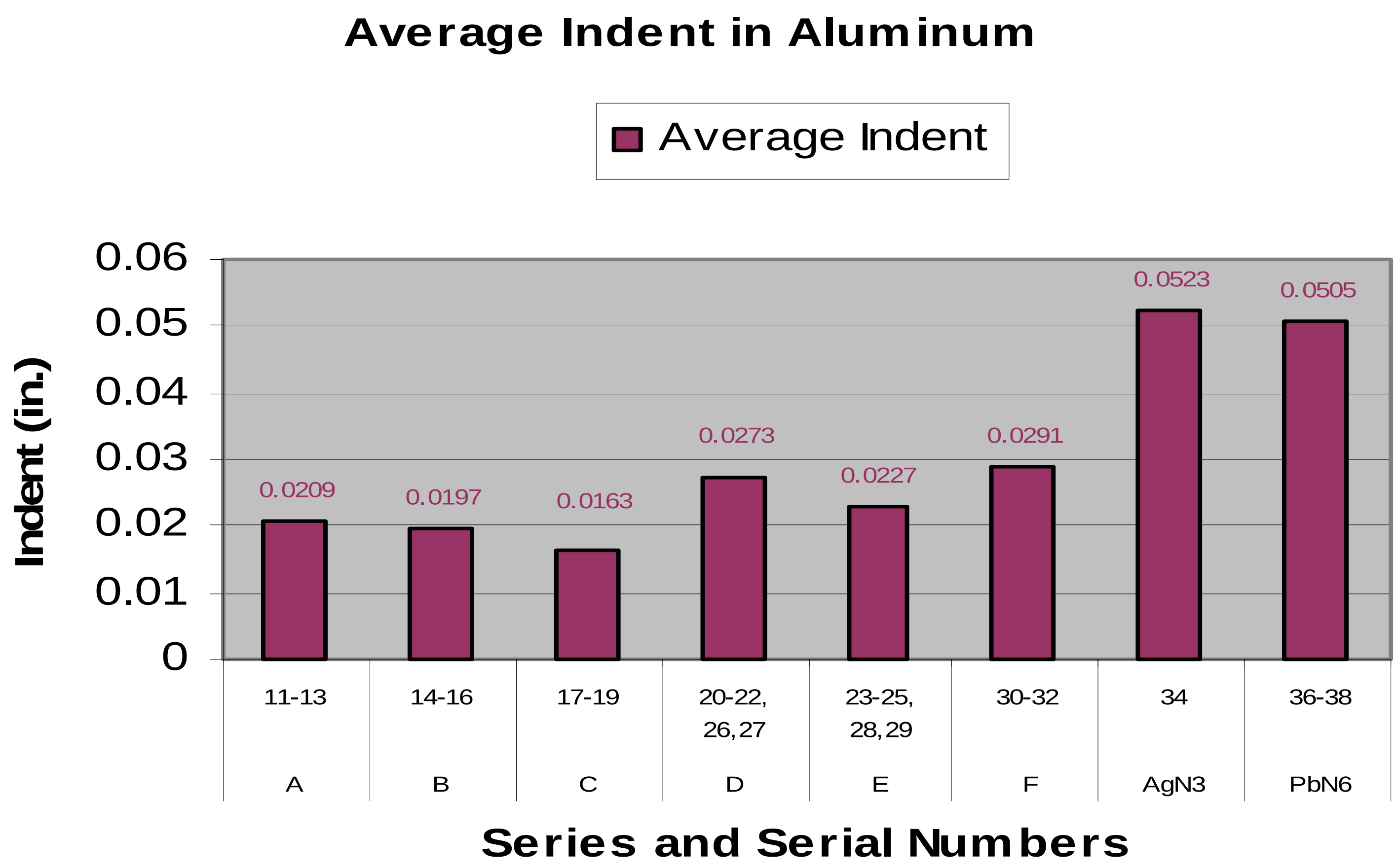
Properties of Costain Silver Azide vs Colloidal Silver Azide

	Costain Silver azide	Colloidal Silver azide	RD1333 Lead Azide
DSC	Endotherm: 310°c Exotherm: 363°c	Endotherm: 310°c Exotherm: 370°c	Exotherm: 323°c
IR (cm^{-1})	3438, 3354, 2036(s), 1630, 648	3451, 3356, 2036(s), 1636, 1382(w), 649	3340, 3331, 2117, 2037(s), 1629, 1329
Friction Sensitivity	No Fire = 10g Low Fire = 15g	No Fire = <10g Low Fire = 10g	No Fire = <10g Low Fire = 10g
Impact Sensitivity	0.047 ± 0.004 joules	0.054 ± 0.001 joules	0.230 ± 0.038 joules
ESD Sensitivity	0.01J (20 TIL)	0.01J (20 TIL)	0.02J (20TIL)

M59 Stab Detonator

- *Two compounds selected for evaluation in M59 hardware*
  - *De-sensitized silver azide*
    - *Compound Synthesized using Costain method to reduce handling sensitivity*
  - *1,5-Diaminotetrazole, Fe complex (28A)*

M59 Detonator Testing



M59 Stab Detonator with DFeP

- Series D had second highest indents
  - 15mg @ 70ksi NOL130
  - 60mg @ 15ksi DFeP
  - 10mg @ 15ksi RDX
- Series F had highest indents
  - 15mg @ 70ksi NOL130
  - 60mg @ 10ksi DFeP
  - 10mg @ 10ksi RDX
- Series A had the highest DFeP content but moderate indent
  - 15mg @ 70ksi NOL130
  - 80mg @ 15ksi DFeP
  - No RDX
- Series C had highest RDX content but lowest indent

M59 Stab Detonator with DFeP

- 10ksi loading pressure is preferred
  - PacSci data suggested this w/o output
  - This data shows RDX detonating at 10ksi
- RDX may not be sufficiently driven to strong detonation. Could imply problems transitioning shock to leads or boosters. More work is needed characterizing shock performance rather than random application testing.
- DFeP shots with Brass Confinement can meet .125” min lead disc requirement.
- DFeP has only ½ to 2/3 the indent performance of azides.

Future work

- Enhance crystallization of 13A
- Investigate the use of other oxidizer groups to replace the perchlorate group used in compound 28A.
- Develop a method to further de-sensitize silver azide
- Evaluate the use of Nano material in primary explosives
- Evaluate new compounds as they become available

ACKNOWLEDGEMENTS
Team members

- Magdy Bichay - NSWC-IH
- Dr. Alfred Stern – NSWC-IH
- Gerald Laib - NSWC-IH
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- Dr. Michael Hiskey - LANL
- Dr. Robert Chapman - NAWC-CL
- Dr. Jeffery Bottaro - SRI International
- Dr. Charles Winter – Wayne State University
- Dr. Farhad Forohar - NSWC-IH
- Dr. Phil Pagoria – LLNL
- Dr. Cliff Bedford - ONR

GENERAL DYNAMICS

Armament and Technical Products

APKWS Flight Test Results

Validation of Aerodynamic Coefficients

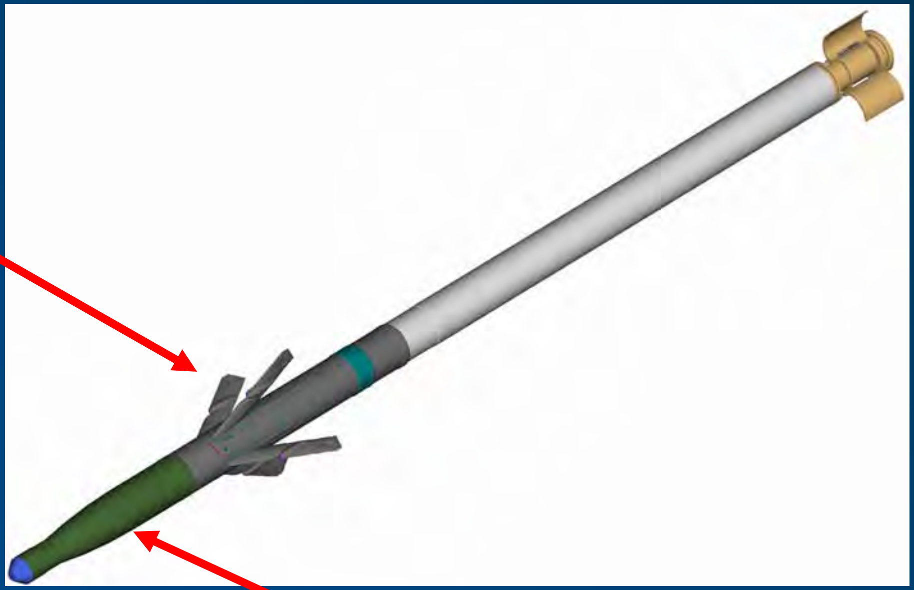
Mr. Larry Ingram and Mr. Dean Slocum

April 27, 2005

Agenda

- APKWS Guided Rocket
- F-4 Telemetry Data
- Validation of Aerodynamic Coefficients
- Preprogrammed Flight F-4 Maneuvers
- Inertially Guided Flight F-4
- F-4 Post-flight Analysis
- Guided Flight F-6A
- Lessons Learned

APKWS Guided Rocket



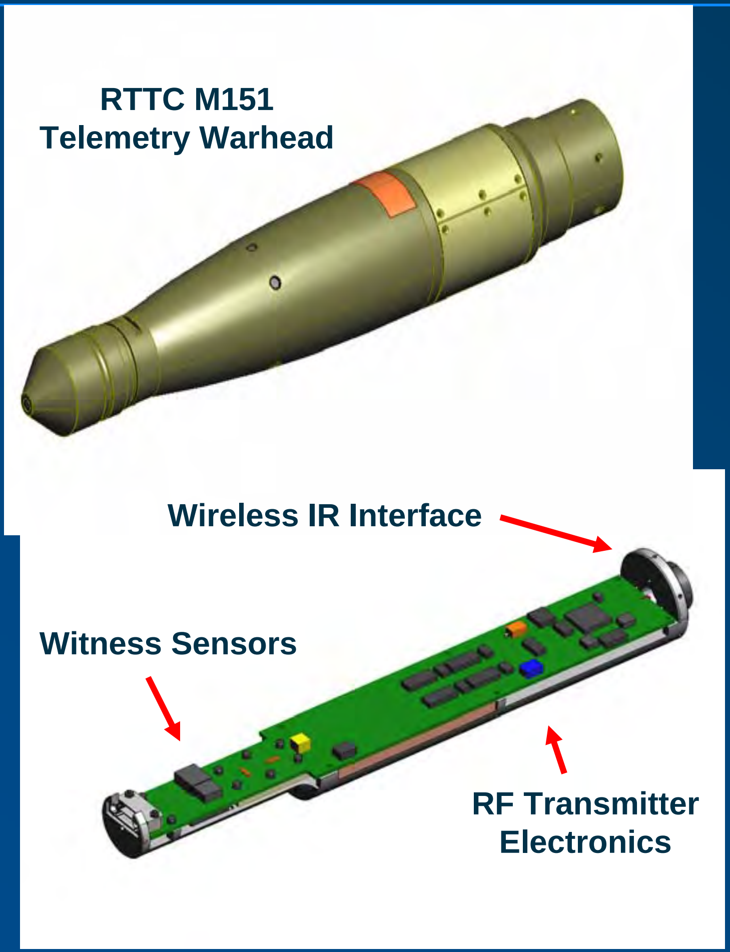
MK 66 MOD 4
2.75-inch Rocket Motor

Guidance Section

M151/M423
Warhead & Fuze

Telemetry Warhead used in DT Flights

F-4 Telemetry Data



Witness Sensors Provide:
- Axial acceleration
- Lateral acceleration
- Normal acceleration
- Yaw rate
- Pitch rate
- Roll Rate
- Y axis magnetic field strength
- Z axis magnetic field strength

Guidance Section IMU Provides:
- Yaw rate
- Pitch rate
- Roll rate

Other G&C Data:
- Seeker Angle and LOS Rates
- CAS Data

Validation of Aerodynamic Coefficients

Aerodynamic Coefficients –NASA Ames

Guidance Section Autopilot

Pre-programmed IGTV Flight F-4

Post-flight TM Data Analysis

Validated Aero Coefficients

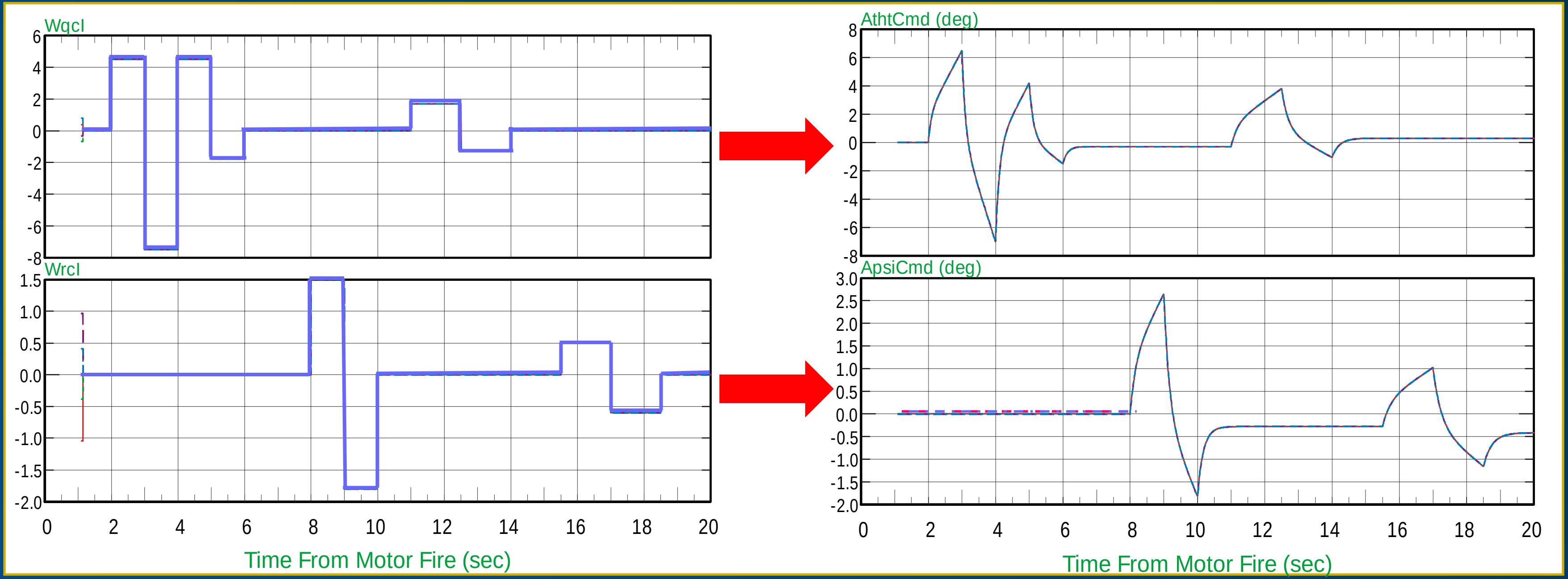
Preprogrammed Flight F-4 Maneuvers

- Preprogrammed Autopilot Rate Commands
  - Aerodynamic coefficients from NASA Ames Tunnel data
- Flight Path Angle Rate Commands Processed Through Lead Compensation
  - Provides steady trim conditions for validating aerodynamic control derivatives
  - Resulting body rates indicate aerodynamic control power
- Roll, Pitch, and Yaw Fin Test Tones Added to Observe Control Derivatives at Trim Conditions
  - Roll fin tone: 3 degrees at 20 Hz
  - Pitch/Yaw fin tone: 6 degrees at 10 Hz

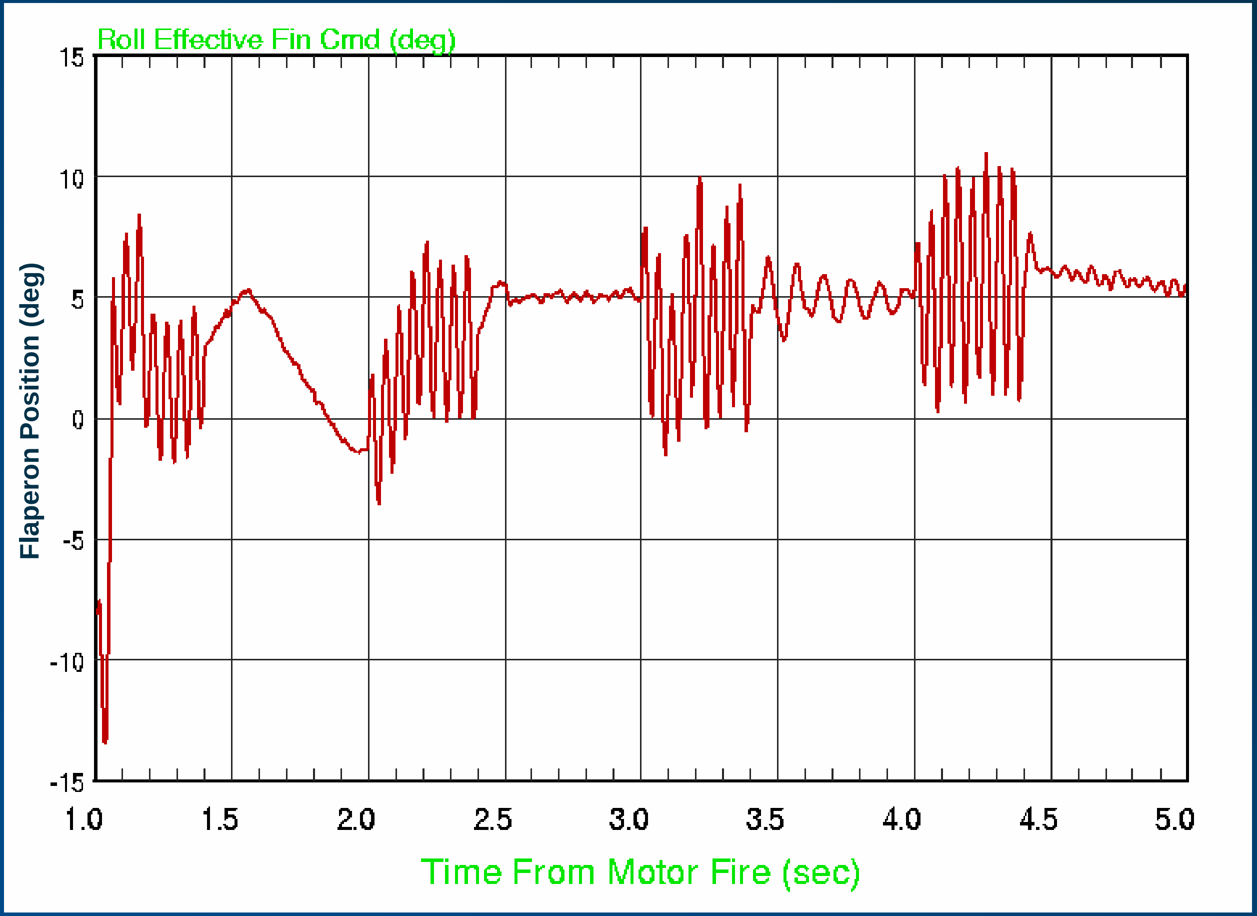
IGTV Flight Path Angle Rate Commands and Body Attitude Commands

Flight Path Angle Rates (deg/sec)

Body Attitude Commands (deg)



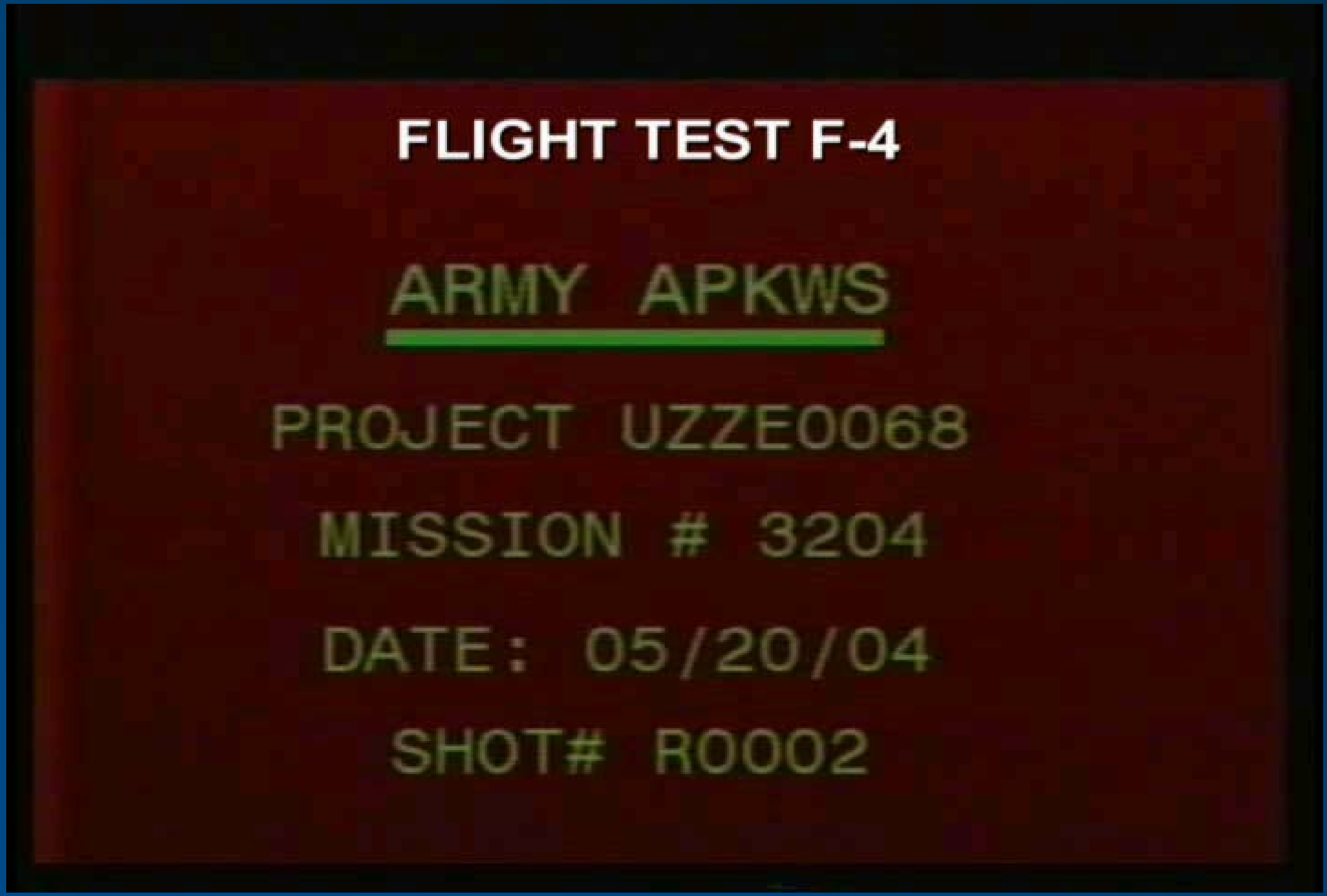
Roll Fin Tones



IGTV Flight Test F-4

- Inertially Guided Test Vehicle Flight F-4
  - Guidance loop intentionally deactivated
  - Ambient Temperature
  - Ground Launched: Army M260 Launcher
  - Target Range: 5 km
  - Target Board: 15.3% reflectivity
  - Target Remote Laser Designator: 0.8 km
- Test Results
  - Wings deployed and airframe de-rolled
  - Seeker acquired target during limited period
  - Preprogrammed flight maneuvers and tones executed
  - Characterized airframe performance over 38 sec flight

APKWS F-4 Flight Test Video
May 20, 2004 – Site C-7, Eglin AFB



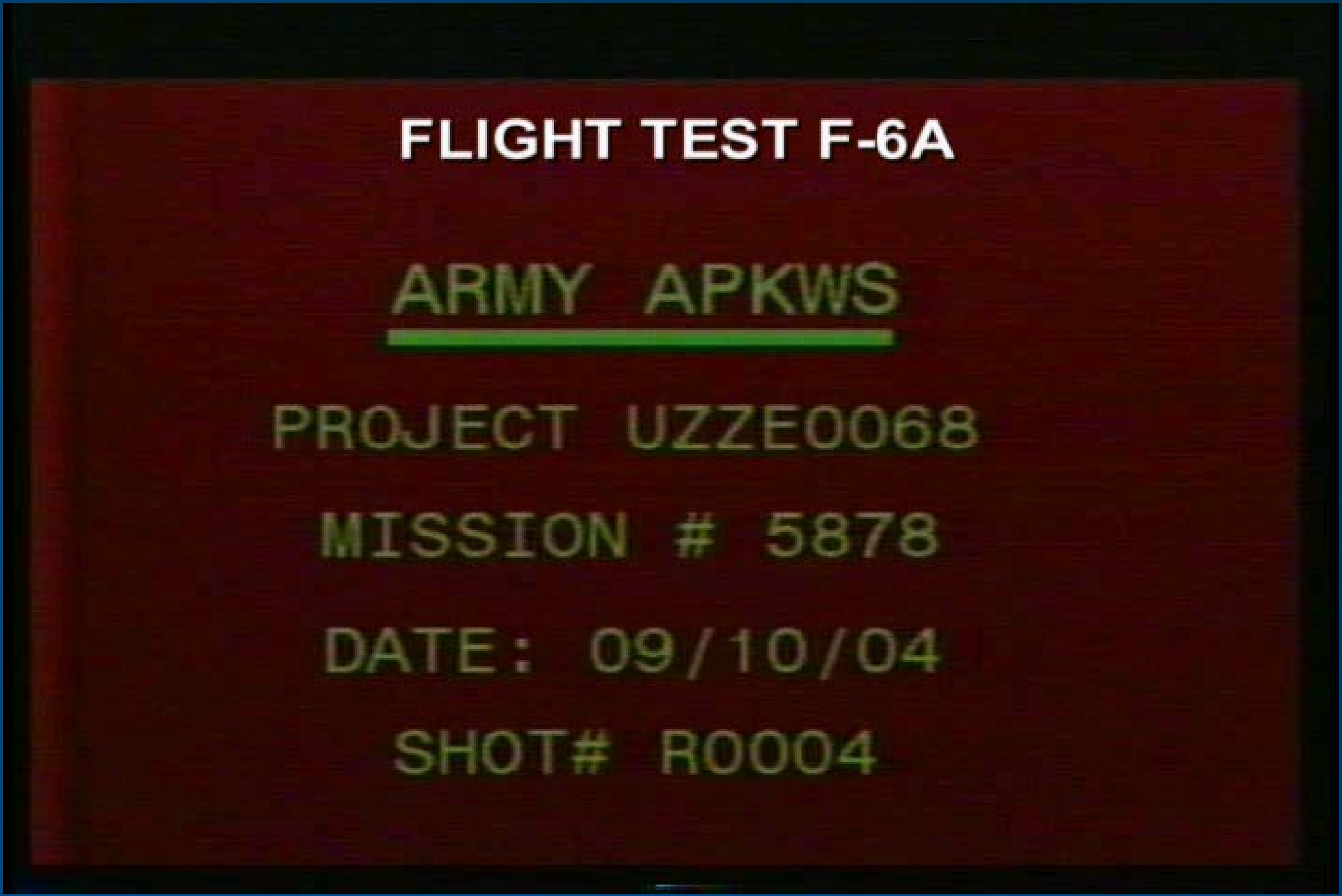
F-4 Post-flight Analysis

- Post-flight Analysis Of F-4 Telemetry Data Revealed Differences In Flight Test vs. NASA Ames Wind Tunnel Aerodynamic Performance
- 6-DOF Model Simulations Were Matched To Flight Test Data To Obtain Corrected Aerodynamic Coefficients
- New Aerodynamic Coefficients Loaded Into Tactical Software
- Updated Tactical Software Flown On Flight F-6A
  - Guidance loop closed to intercept laser designated target

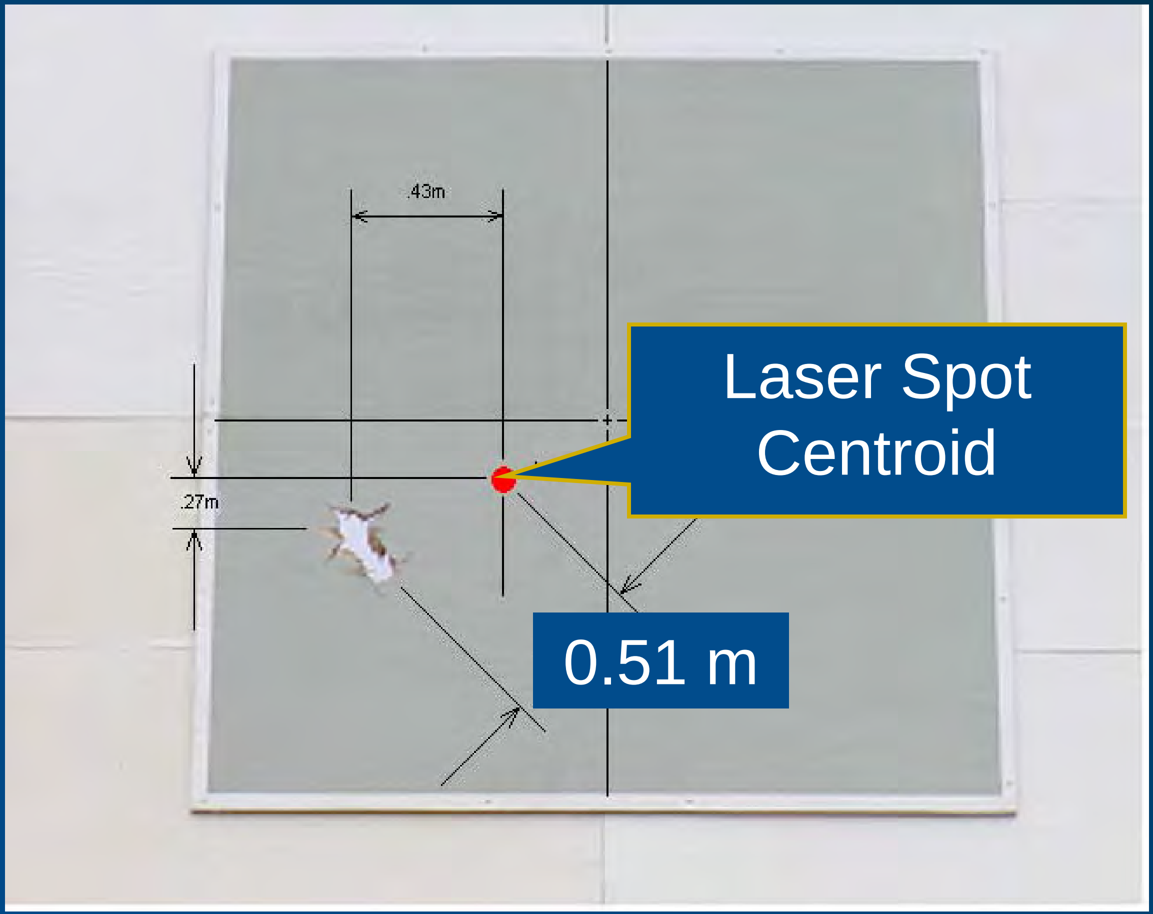
Guided Flight Test F-6A

- Ambient Temperature
- Ground Launch: Army M260 Launcher
- Target Range: 5 km
- Target Board: 31% reflectivity
- Remote Laser Designator: 1.9 km
- Guidance Loop Activated

APKWS F-6A Flight Test Video
September 10, 2004 – Site C-7, Eglin AFB



APKWS Flight Test F-6A
Target Impact from 5 km Range



Lessons Learned

- Comparison to NASA Ames Wind Tunnel Data
  - Drag match accomplished with small drag increase
    - TM warhead antenna features
  - Roll aerodynamics matched with reduced
    - roll control power
    - roll damping

ALCOA DEFENSE

Metallic Materials & Processes

Enabling Lightweight System Initiatives

Alcoa – Howmet
Presentation at NDIA
GARM SYMPOSIUM
27 APRIL 2005

ALCOA

SPEED ★ REACH ★ AGILITY ★ SURVIVABILITY

Purpose

- Establish that Metallic Materials and processes are key enablers for achieving development and production objectives for Lightweight systems
- Illustrate that Lightweight Initiatives are enabled by:
  - Materials technology
  - Innovative processes
  - A total systems approach
  - Rigorous cost value analysis
- Confirm that a balanced approach to design, materials, processes, and cost will enable solutions

Objectives

- **Demonstrate that advances in Titanium alloys and processes have resulted in**
  - **Meeting Lightweight Systems objectives and**
  - **Offering direct applications for achievement of key challenges in armament and protection systems**
- **Illustrate that "new" aluminum alloys offer mechanical properties and other characteristics which will meet design/performance challenges**

Challenges

- Lightweight materials with application specific properties
- Forming high precision complex geometric shapes/contours repeatedly
- Reducing part count – improving manufacturability
- Achieving wrought properties with cast materials
- Introducing "new" materials and processes via concurrent engineering
- Lead-time reduction

Enablers

- "New" alloys responsive to application needs
- Quality control of complex processes
- Stereolithograhy enabled schedule and cost reductions
- Castings yielding near wrought properties
- Demonstrated capability to form complex parts at near net shape – reducing part count, lead time, cost, etc.
- Expanded metals industry links to applications engineering

Applications

- Weapon structures and mechanisms
- Muzzle brakes
- Projectile components
- Warheads
- Structural elements
- Propulsion modules
- Protection systems (armor)

Realizing the Benefits

- Lightweight Systems Initiatives are critical to the development and realization of enhanced legacy systems and supporting Transformation goals.
- Advanced Metallic Materials and Processes have been and are being applied successfully to meet requirements and enable superior Combat operational capability resulting from light weight.

Alcoa Capabilities

- Aluminum Sheet & Plate
- Aluminum Extrusions
- Titanium, Aluminum & Superalloy Investment Castings
- Aluminum Sand Castings
- Titanium, Aluminum & Superalloy Forgings
- Advanced Titanium, Aluminum & Superalloys
- Enclosures
- Prime Services
- Machining
- High Temperature & Wear Resistant Coatings
- High Technology Fasteners
- Design

Howmet Castings – Overview

- Leading Manufacturer of Titanium, Aluminum and Superalloy Precision Investment Castings
  - Military & Commercial Engines and Airframes
  - Lightweight Armament
  - Missiles and Munitions
- Total Solution Provider
  - Machining, Coating (high temp and wear resistant), Supply Chain Management and Design Services
- Supplier of Superalloy and Titanium Ingots, Ceramic Cores and Crucibles, and Advanced Tooling
- Headquartered in Cleveland, Ohio
  - Part of Alcoa Investment Cast and Forged Products

Examples of Titanium & Aluminum Castings

Titanium Armament

- **Market need for light-weight artillery**
  - **Greater transportability/ rapid deployment**
- **Cast titanium offers:**
  - **Light weight and high strength**
  - **Lower cost than fabrications**
  - **Reduced manufacturing time**
  - **Potentially better performance than fabrications**

M777 Howmet Titanium - In The News

- *Machine Design* November 2003
- *Modern Casting* December 2003
- *Engineered Casting Solutions* Winter 2004
- *Marine Corps Gazette* June 2004
- *Materials World* June 2004

ALCOA DEFENSE

Engineered Casting Solutions – 2004

<u>Co-Author</u>: <u>**Robert Nestor**</u>

US Army Industrial Ecology Center, Casting Emission Reduction Program

"The successful implementation of **thin-walled** titanium castings has been **crucial** in achieving **full-rate production** requirements of the howitzer while **maintaining quality**."

ALCOA

M777 Part Count Reduction*

Titanium Structure	Fabrication	Casting	Reduction
Cradle	324	172	47%
Body	215	11	95%
Saddle	116	5	96%
Stabilizers	70	2	97%
Spades	120	2	98%
Trails	98	2	98%
Elevating Yoke	19	1	95%
Buffer Yoke	11	1	91%
Total	973	196	80%

*http://www.machinedesign.com/ASP/strArticleID/56460/strSite/MDSite/viewSelectedArticle.asp

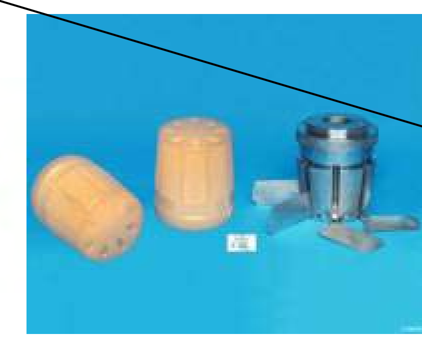
NDIA GARM Symposium
April 27, 2005

ALCOA DEFENSE

Projectile Castings

Nose Cone

Base

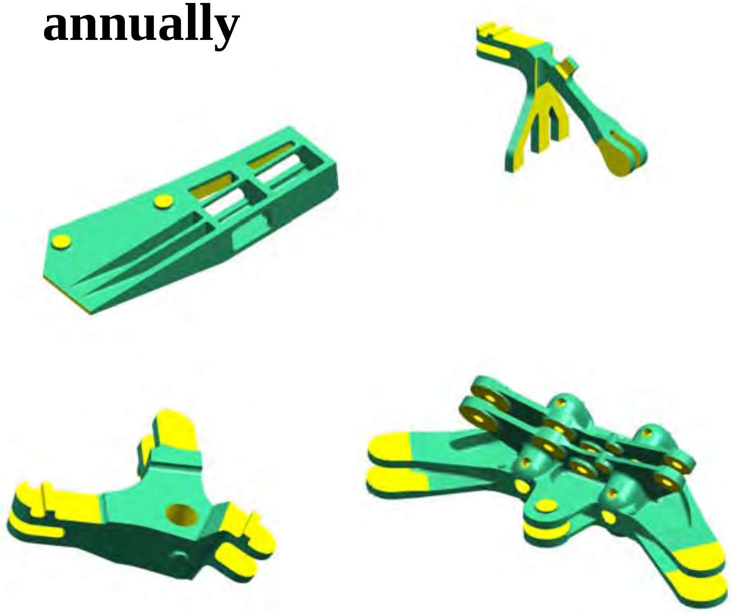


SPEED ★ REACH ★ AGILITY ★ SURVIVABILITY

ALCOA

Examples of Other Titanium Parts

- HTC currently ships >$2M of brackets, mounts and clevises annually



- HTC will ship >$7M in turbocharger wheels for the commercial transportation market this year (~117,000 units)

Examples of Aluminum Castings

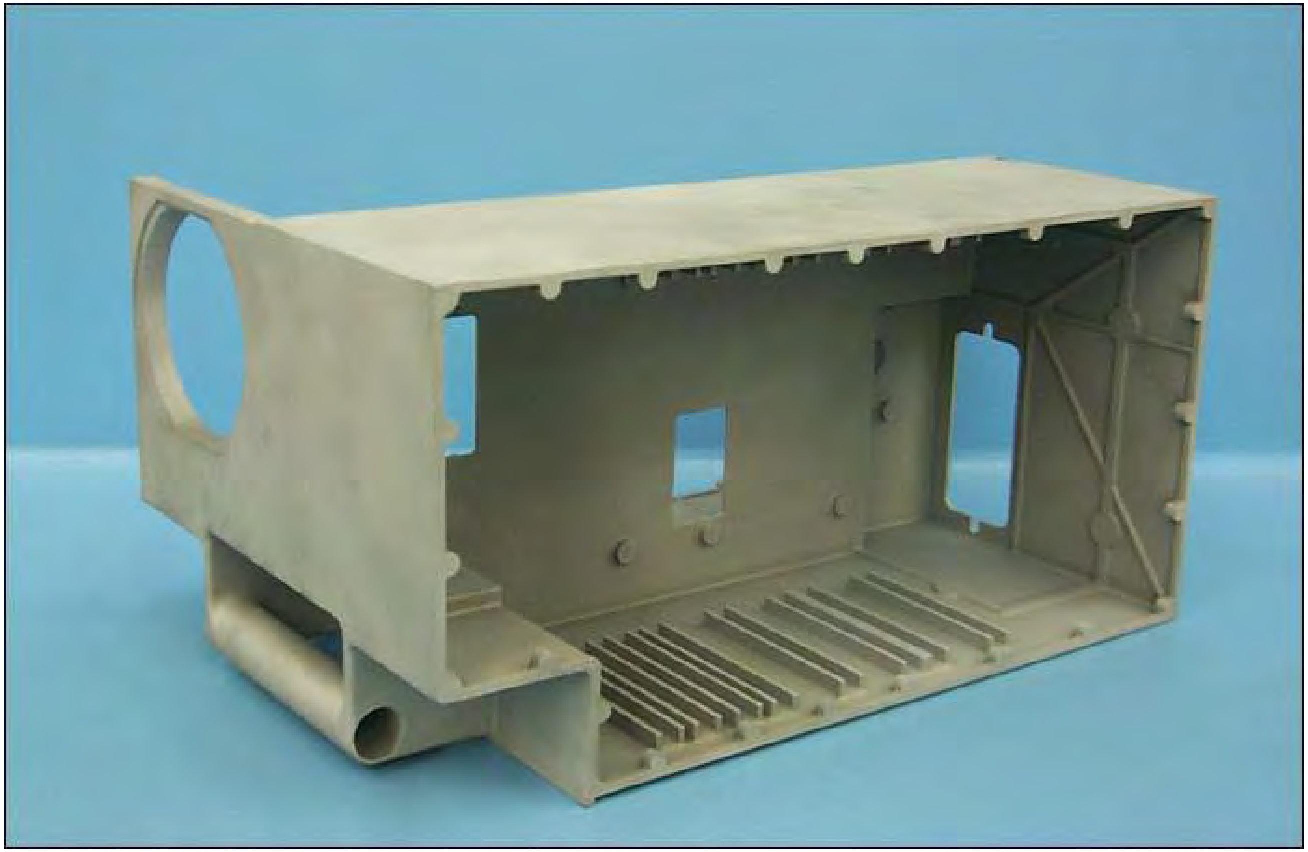
Howmet's Bethlehem Casting Component
Eliminates 50 Man-hours of Assembly

Dimensions: 36" x 24" x 14"

Large Structural Aluminum Parts

Dimensions: 48” x 20 dia”

Electronic Enclosures



Investment Casting Process

Rapid Prototype can be used instead of tooling

Die Construction

Wax Injection

Wax Assembly

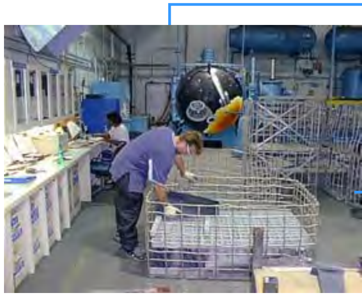
Shell Build

Dewax

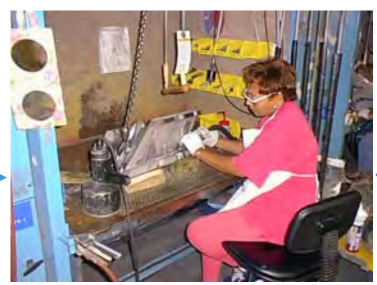
Casting

Shell Removal

Cut-off



Heat Treat



Finishing

FPI/Visual

X-Ray Inspection

Casting Capabilities – Aluminum/Titanium

Process	Material	Pour Capacity	Working Envelope
Aluminum	200 and 300 series aluminum	750 lbs	48” x 75”
Small Titanium	Ti 6-4, Ti 6-2-4-2, Ti 5553	200 lbs	<32” diameter
Large Titanium	Ti 6-4, Ti 6-2-4-2, Ti 5553	1,600 lbs	<62” diameter

Advancements in Investment Casting

- **Exciting “New” Alloys**
  - Cast titanium with forged properties
  - High strength aluminum casting alloy under development
- **Automation/Robotics Enabling Efficient High Volume Production**
  - Satisfying demands for commercial transportation vehicles
- **Ability to produce very small and large 3D single piece castings**
  - Titanium parts up to 62” in diameter
  - Aluminum parts up to 70” in length
- **Lead times down from 16 weeks to 4-6 weeks**
- **Development hardware available in a few weeks utilizing SLA and electronic technologies**

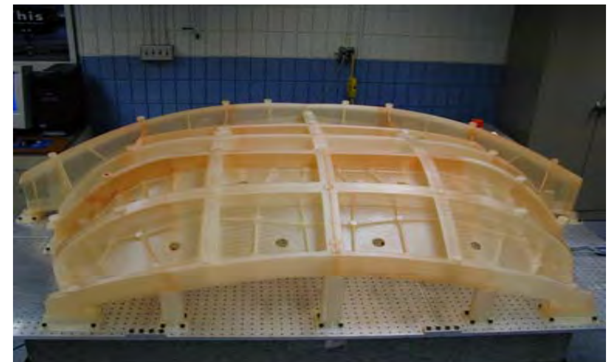
Cast Material Properties

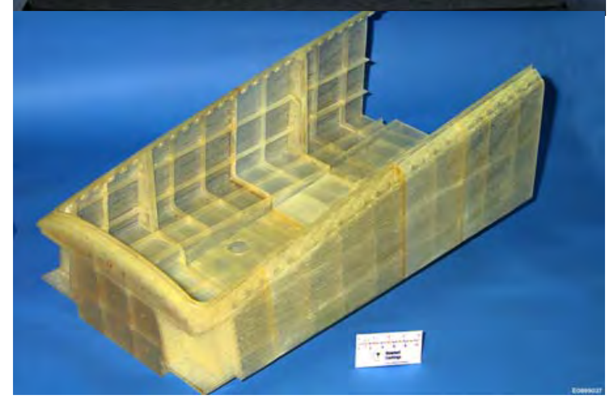
Titanium				
Alloy	**Treatment**	**σ_{uts} (ksi)**	**σ_y (ksi)**	**% el.**
Ti 6-4	HIP+Anneal	130	120	6
Ti 6-2-4-2	HIP+Anneal	125	115	8
Ti 5553	Stabilized	168	153	9

Aluminum				
Alloy	**Treatment**	**σ_{uts} (ksi)**	**σ_y (ksi)**	**% el.**
A356	T6	32-45	28-34	3-5
D357	T6	45-50	36-40	2-3
C355	T6	41-50	31-40	2-3
A201	T7	60	50	3-5

Development Capabilities

- Pre-Production Use of Electronic Data
  - Solidification Modeling
  - Concurrent Engineering
  - Wax Tooling
  - Inspection
- Rapid Prototyping
  - SLAs
  - Complex Pattern Fabrications
  - 1-2 Week Lead-times
  - Electronic Files are Critical





Evolution of Alcoa Design Activities

Audi Space Frame → A3I → ALSI

ALSI Objective

To integrate Alcoa's *proven* capabilities into the design of *new* and *legacy* military ground vehicles:

- Design methodology
- Depth of material expertise
- Breadth of manufacturing capabilities

ALSI Goal

To partner with military ground vehicle OEM's to provide the Army with *cost-effective weight reduction* through the implementation of Alcoa/OEM solutions.

GOAL: 25%-50% reduction in weight
(system dependent)

Conclusions

- **Advanced Metallic Materials have enabled achievement of key lightweight system initiatives and are in the process of supporting others**
- **Capabilities are evolving and focused to meet needs of armament and protection community by addressing**
  - **Materials technology – to achieve desired properties**
  - **Processing technology – to ensure effective integration in complex configurations at an affordable cost**
  - **Design expertise – to assist OEM's in meeting their lightweighting goals in a cost-effective manner**

Development of the M1028, 120mm Anti-Personnel Tank Round

Presented by:

Hugh Mac Millan

US Army Armaments Research, Development & Engineering Center

Neal Hylton

General Dynamics – Ordnance and Tactical Systems

M1028 Background

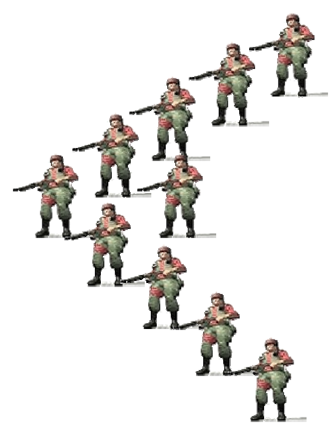
- ACAT III Program
- The Canister round was developed to meet a war fighting requirement for 2ID Korea

CHRONOLOGY:

- January 1999 - U.S. CINC in Korea issued a message that the Korean theater needed a short-range (100-300m) tank fired anti-personnel cartridge.
- December 1999 - Urgency of Need Requirement from HQ, United States Forces, Korea was received
- January 1999 to July 2002 – ARDEC development of the XM1028
- July 2002 - PM-MAS competitively awarded the 120mm, XM1028 Canister contract to General Dynamics Ordnance and Tactical Systems (GD-OTS).
- December 2004 - Achieved MILESTONE C (Type Classification – Low Rate Production)

M1028 Requirements

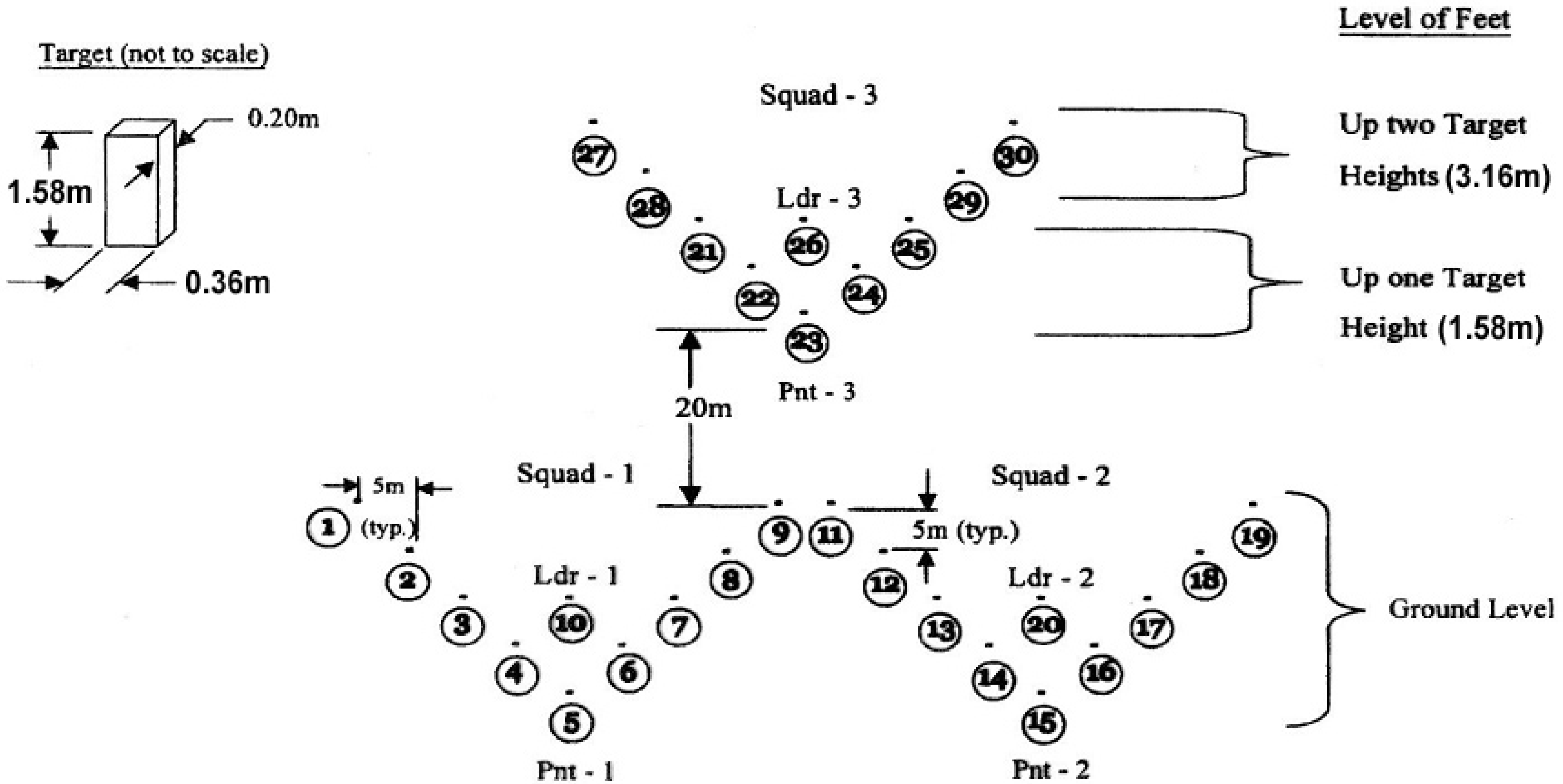
- **Defeat ≥50% Advancing Squad w/ 1 Shot**
- **Defeat ≥50% Advancing Platoon w/ 2 Shots**
- **200-500M (threshold)/100-700M (objective)**
- **Muzzle Action (i.e. No Fuze)**
- **No orientation of the projectile**
- **Vulnerability no worse than current fielded**



Cartridge 120mm: Canister XM1028

Troop Array, Squad in Wedge

2 Up - 1 Back (Top View)



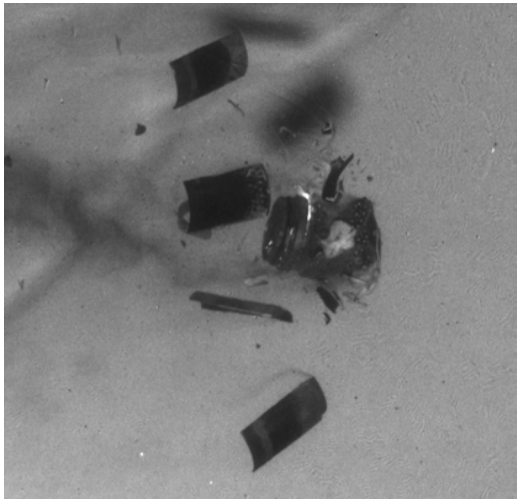
Test Set-up

16" by 150' Canvas Target at 400m

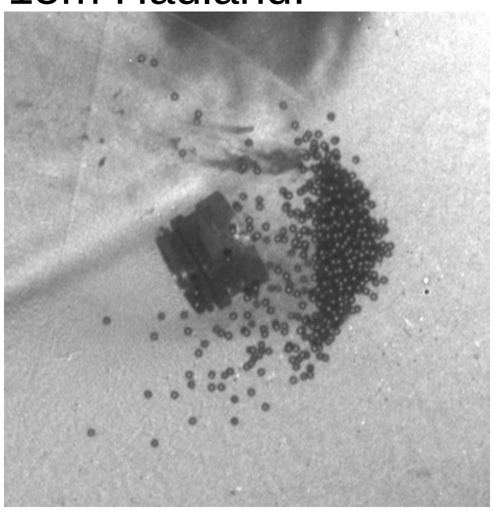
GENERAL DYNAMICS
Ordnance and Tactical Systems

Test Pictures/Video

5m Hadland:



15m Hadland:



Flight Follower Video:

GENERAL DYNAMICS
Ordnance and Tactical Systems

Projectile Designs

Plastic ARDEC Design:

Aluminum ARDEC Design:

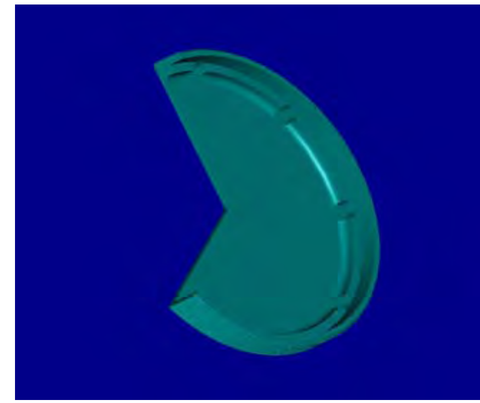
ARDEC Patent Pending

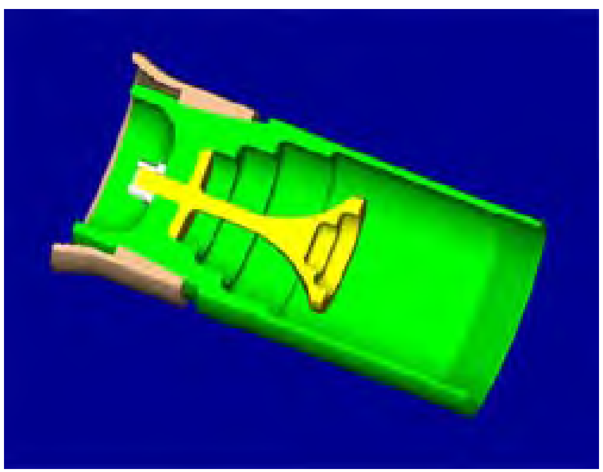
GENERAL DYNAMICS
Ordnance and Tactical Systems

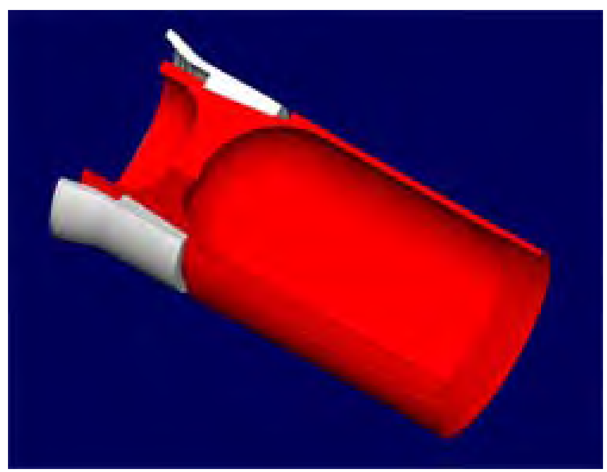
M1028 Design Evolutions

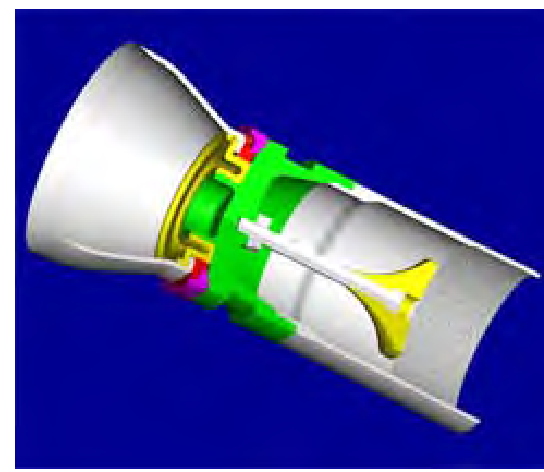
- During the development of the M1028 the following were traded/tested to meet user requirements

- different shape payloads
- different payload sizes
- different lid designs
- different spreaders to dispense payload
- different projectile designs









GENERAL DYNAMICS
Ordnance and Tactical Systems

M1028 Cartridge Design

First IM Compliant Tank Round

- Tungsten Sphere Payload (~1100)
- Frangible Cap, Aluminum
- Improved Spring Disc with Modified Case Base
- Improved Propellant Bag Forward Closure
- Rubber Coated Primer

120mm M1028 Canister Round
Alternate Target Demonstration

- User Community Requested Performance of M1028 Against Alternate Targets:
  – Block Wall
  – Triple Strand Concertina
  – Car

Wall Test Set-up

- Wall is 10 ft in height by 20 ft in width
- Set 45 degree's to line of fire within range requirements
- Built with standard construction on concrete footer – no rebar or fill in blocks
- 5 dummies constructed of ¾ in plywood set up behind wall

Wall Test - Conclusions

- Wall perforated to the extent that it can no longer support itself and collapses
- All dummies behind target are perforated multiple times
- Two dummies still standing due to debris on base

GENERAL DYNAMICS
Ordnance and Tactical Systems

Concertina Wire Test Set-up

- Triple Strand Concertina set within range requirements
- Pinned at each end

Before

After

GENERAL DYNAMICS
Ordnance and Tactical Systems

Car Test Set-up

- Mid 1990's 4 door sedan selected as target
- 15 degree to line of fire within range requirements
- Car is operational
  - Transmission in Park
  - Engine running
  - Fuel tank ¼ full

GENERAL DYNAMICS
Ordnance and Tactical Systems

Car Test After M1028 Shot

- Car is penetrated from front to rear
- Car decimated by M1028 impact and then consumed by ensuing fire
- Fire starts in two places
  - Under hood
  - Back near rear axle

GENERAL DYNAMICS
Ordnance and Tactical Systems

Car Test After M1028 Shot

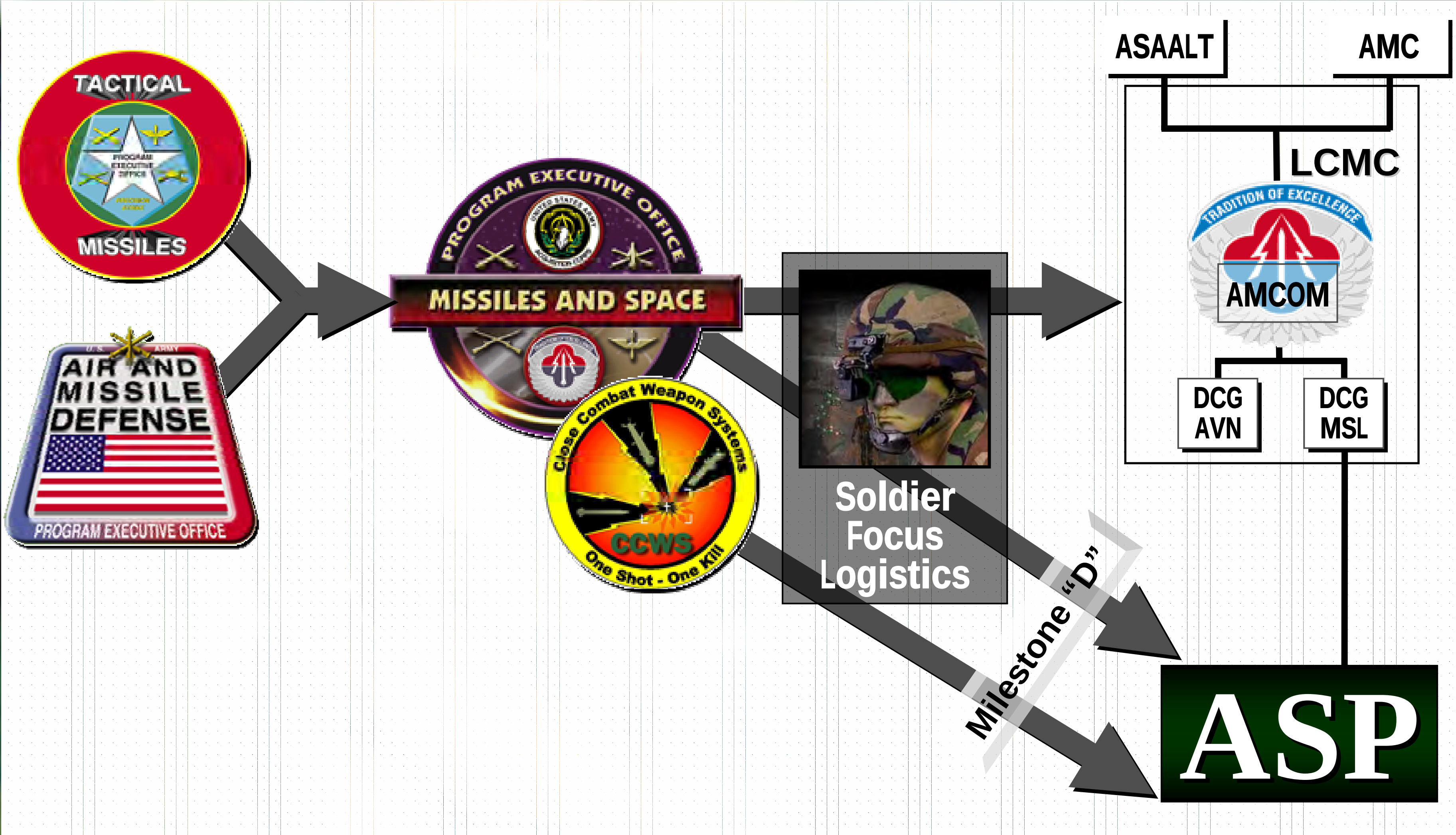
M1028 Summary

- The M1028 has gone through an intensive design/model/fab and test to meet User requirements
- Achieved Milestone C (TC-LRP) Dec 04
- Scheduled to achieve TC-STD 3rd Qtr 05
- M1028 also proves very effective against alternate targets
  - Normal block walls
  - Concertina wire
  - Cars

GENERAL DYNAMICS
Ordnance and Tactical Systems


PROGRAM EXECUTIVE OFFICE
MISSILES AND SPACE
Program Executive Office
Missiles and Space
Acquisition and Sustainment Program
"Any Soldier, Anywhere, All the Time"
COL Lloyd McDaniels
Project Manager
CCWS Project Office
U.S. Army
Redstone Arsenal, Alabama

Dynamic Times in the Missile Community



Life Cycle Management Command Vision

- The objective of this initiative is to *faster, make good products even cost, and enhance the synerg Acquisition, Logistics and T* intended to integrate significant responsibilities and authority to en between the Army Materiel Comma Commands (MSC nd the Progra The PEOs will be work as ar

"The PEOs will be able to work as an integral part of the AMC MSCs, while continuing to report directly to the Army Acquisition Executive (AAE); likewise, logisticians in AMC will have enhanced input into the acquisition processes to influence future sustainment and readiness."

"The life-cycle management initiative will provide an integrated, holistic approach to product development and system support."

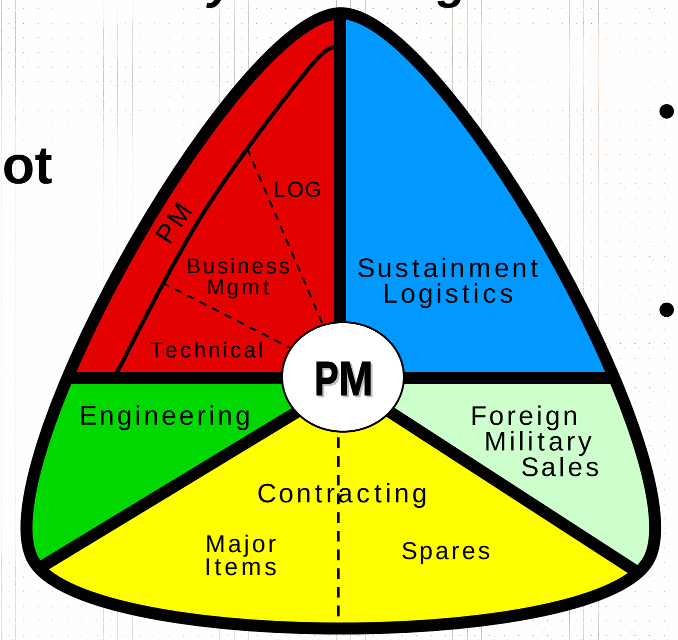
SFL is a Primary Method to Realizing this Vision

Integrating Program Management and Execution

Problems

- Life Cycle Management Still Not Under One Leader
  - PM - TLCSM
  - IMMC - Sustainment
  - SAMD - FMS
  - RDEC - RDTE / Sust Eng
  - ACQ CTR - OMA Central Procurement

Soldier Focused Life Cycle Management



Really Give PM the Resources and Authority to Match the TLCSM Charter

Solutions

- Make the PM the Life Cycle System Manager
- Delegate Authority for:
  - Funding
  - Personnel (Core, Matrix)
- Accountability for Life Cycle
  - Cradle to Grave

PROGRAM EXECUTIVE OFFICE
MISSILES AND SPACE

Acquisition and Sustainment Program Concept

Post "MS" System Sustainment

- Provide Focused Sustainment Effort
- Maintain CM/SE/Logistics Under One Manager
- Synergistic Management of Various Fund Sources… PA, RDT&E, OMA, SSTS, Spares
- Program Management Provides Synchronized Budget and Execution Plans

Continued "PM" Responsibility & Post PM Opportunity

Mission Statement

Provide the Soldier with Superior Technology and Logistic Support to Meet the Requirement for Close and Long Range Tactical Fires

End State

- **Integrated Office Capable of:**
  - **Improving, Producing, Fielding, Training, and Sustaining Assigned Weapon Systems**
  - **Leading an Integrated Workforce to Ensure High States of Readiness of Fielded Systems**
  - **Executing the Life Cycle Support Program**

One Stop Shop for Fielded Systems

Specified and Implied Tasks

- Specified Tasks
  - Total Support of Fielded Weapon Systems
  - Continue Production and Improvement of Fielded Systems
  - Strengthen Linkage to the Warfighting Soldier
  - Provide Acquisition Expertise and Discipline for Life Cycle Support
  - Accept Programs Post Milestone "D"

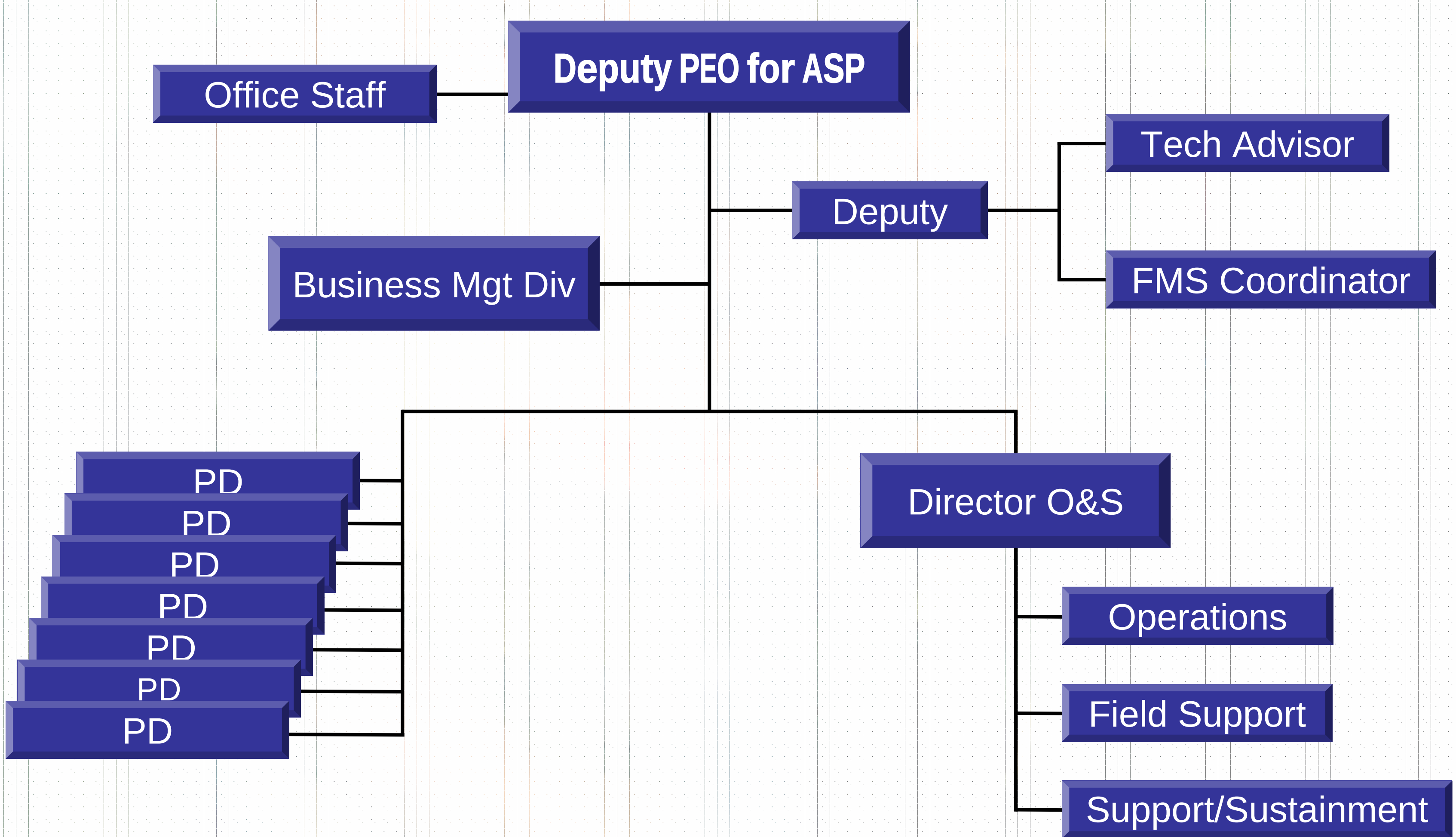
Specified and Implied Tasks

- **Implied Tasks**
  - **Manage the Total Current Systems Budget**
  - **Manage a Fully Integrated Functional Staff**
  - **Maintain Total Asset Visibility**
  - **Provide Rapid Reaction to the Field**
  - **Provide a Sustainment Planning Capability**
  - **Interface with Other Government Logistic Agencies and Contractors**
  - **Professionally Develop Workforce for Sustainment and Acquisition Processes**

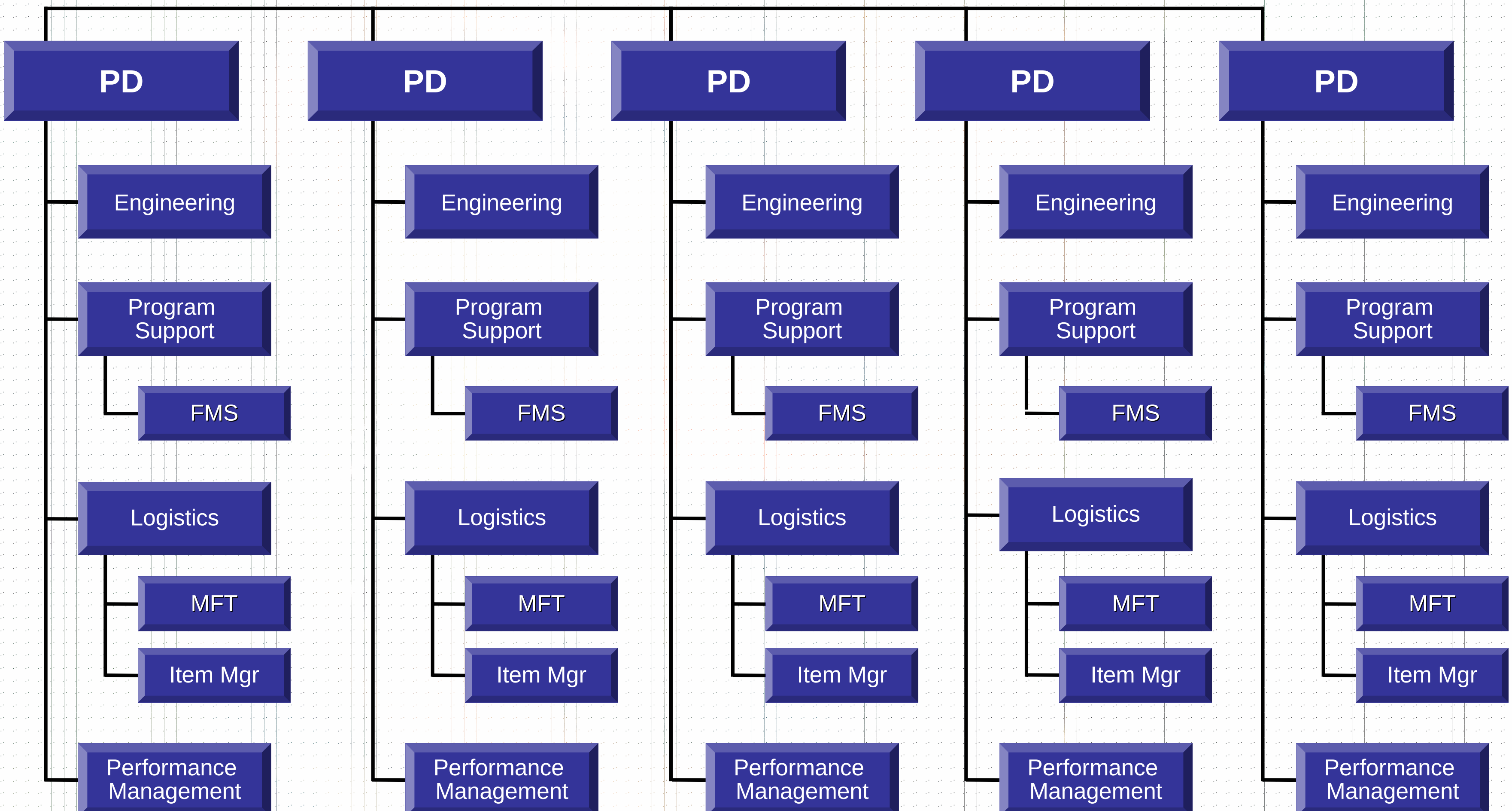
Our Primary Responsibility

Sustain Weapons that are a Credible Deterrent in Peace and that Effectively Perform the Mission in War

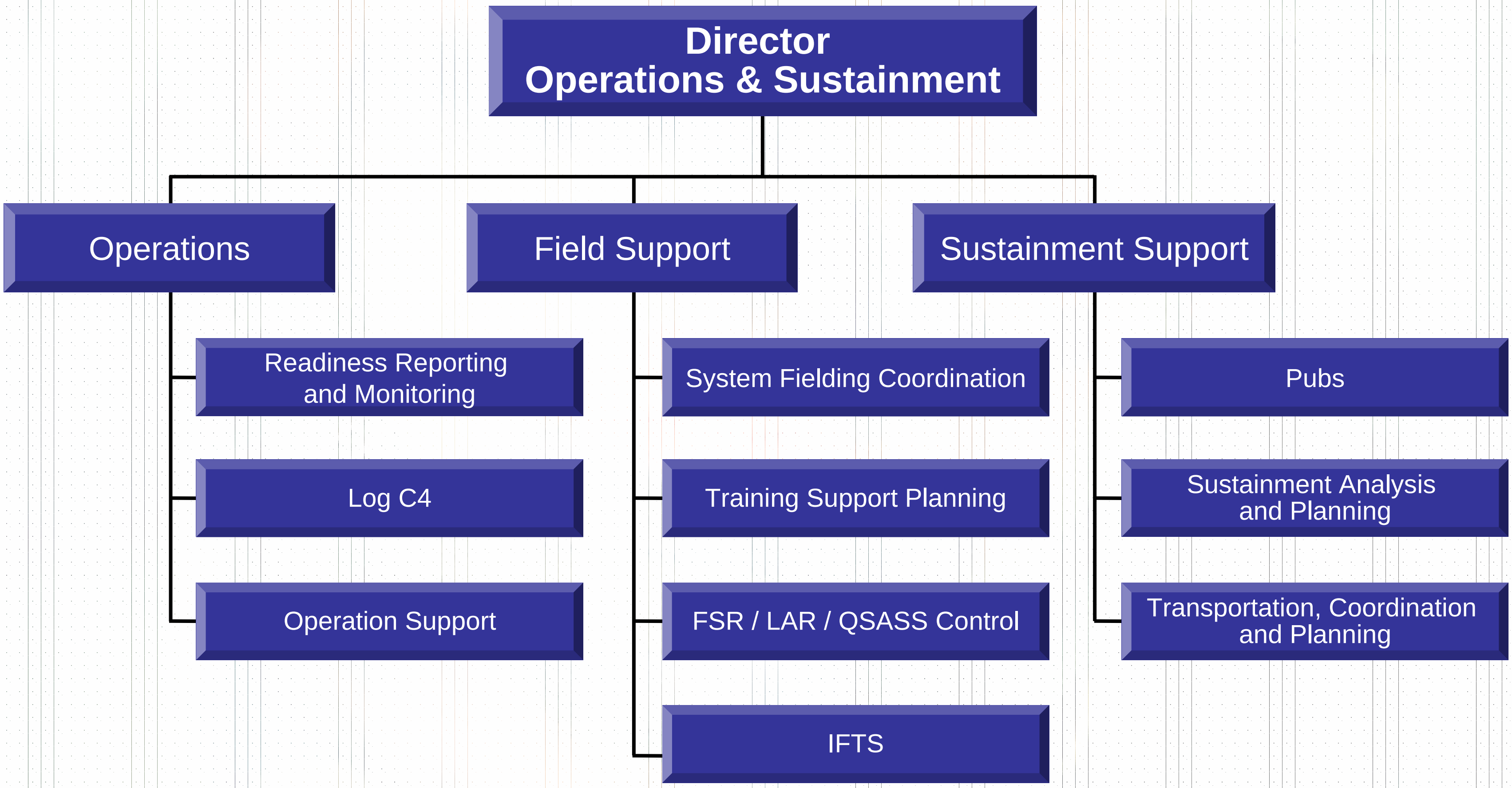
ASP Organizational Structure



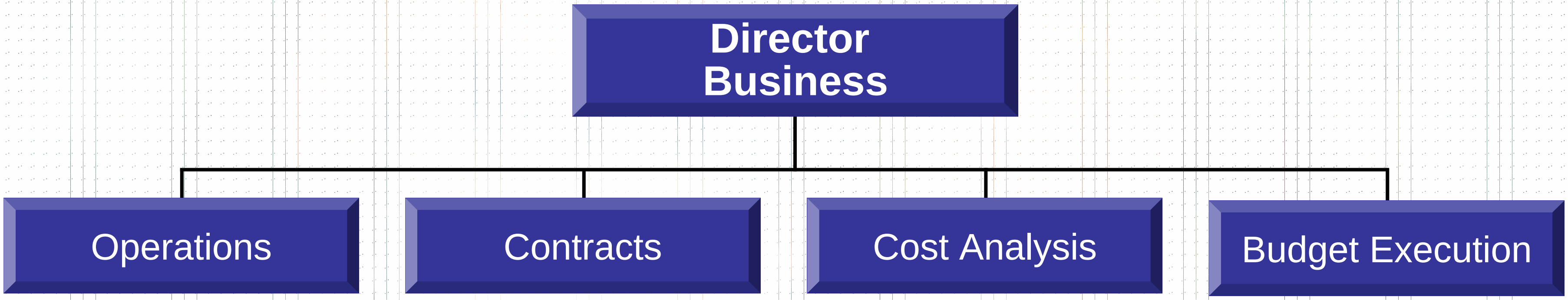
Product Management Organization



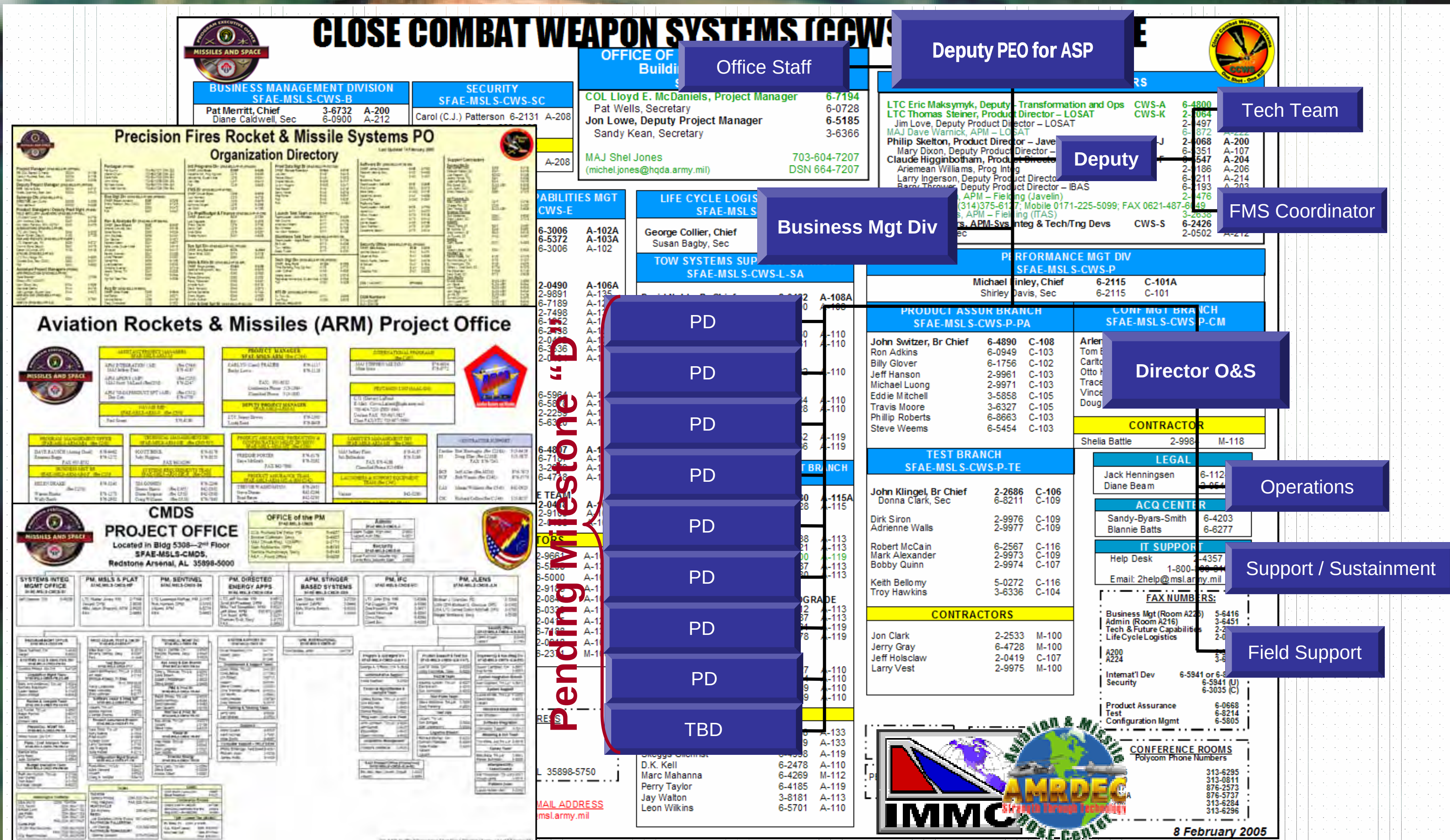
Operations and Sustainment Division



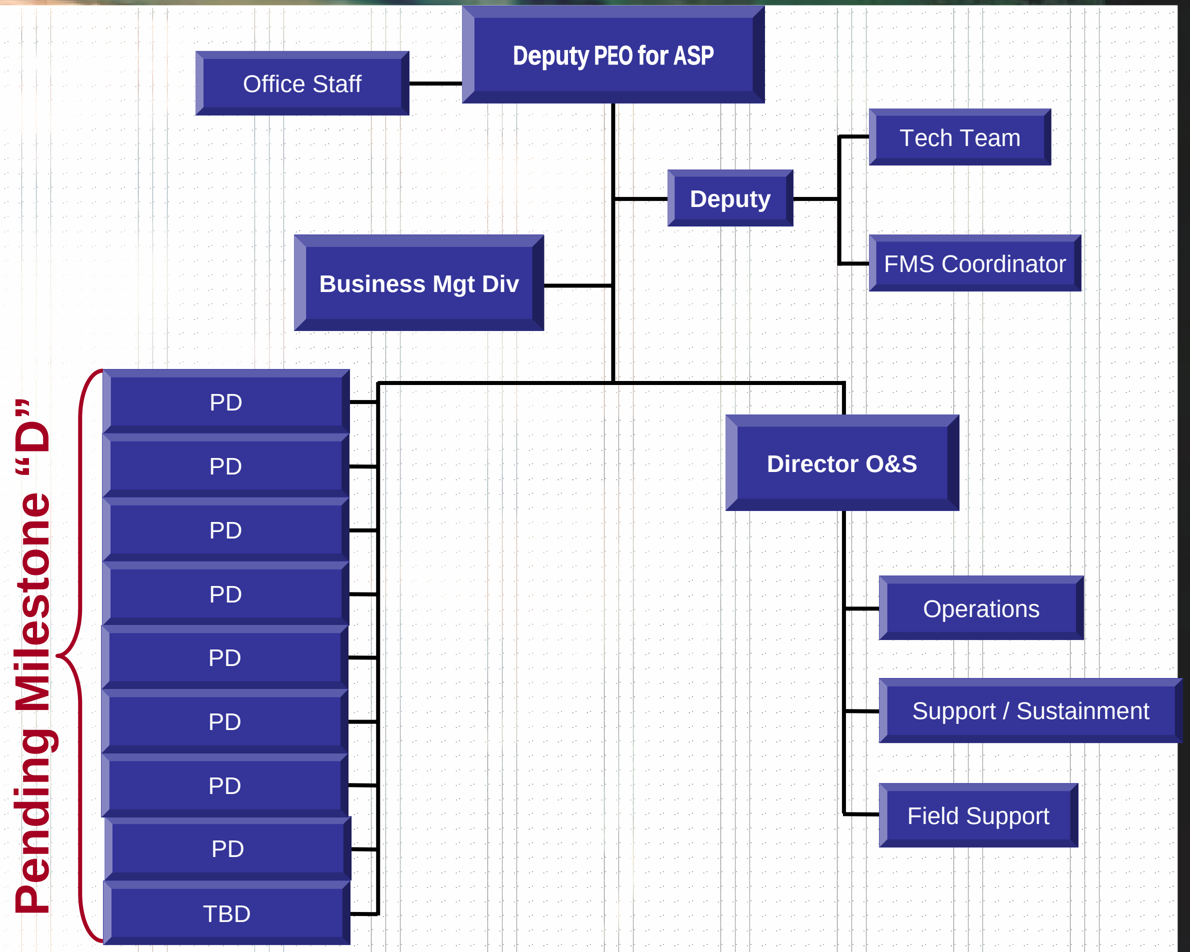
Business Division



Transition Execution Over Time



Transition Execution Over Time



Milestone “D” Phased Process

Phase I
Pre-Milestone “D”

Determine Candidates

- Purpose
  - Allows PM an Opportunity to Provide a Reclama
  - Uses Criteria for Consideration
- Criteria
  - % Program Budget Spent
  - Funding with Dollars by Year
  - Configuration MGMT/Production
  - % Fielded
  - Human Systems Integration
  - Operational Readiness, Support and Training
  - Chartered Product/ Program Manager?

Phase II
Milestone “D”

Make a Decision

- Purpose
  - Provide Sufficient Information to the PEO to Determine if a Management Change is Beneficial
  - Determine if this Makes Sense for the Army

Phase III
Transition

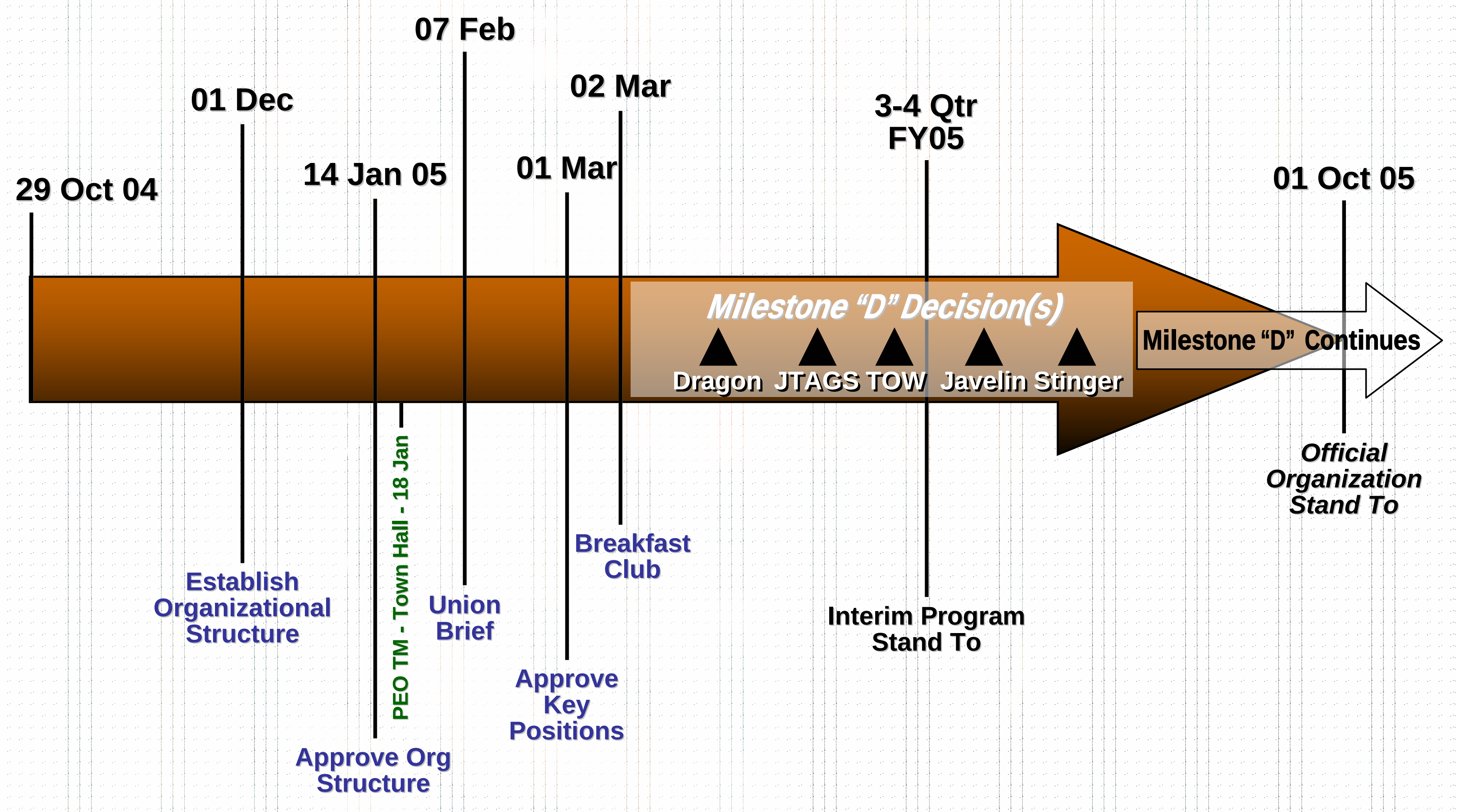
To ASP

- Purpose
  - To Conduct Transfer of Information and Resources from Current Program Manager (PM) to Receiving PM
  - Transition of Data Products, Personnel and Resources

Objective

Increase Readiness

Timeline


07 Feb
01 Dec
02 Mar
3-4 Qtr FY05
14 Jan 05
01 Mar
29 Oct 04
01 Oct 05
Milestone "D" Decision(s)
Dragon
JTAGS
TOW
Javelin
Stinger
Milestone "D" Continues
PEO TM - Town Hall - 18 Jan
Official Organization Stand To
Breakfast Club
Establish Organizational Structure
Union Brief
Interim Program Stand To
Approve Key Positions
Approve Org Structure

Summary

- Organization Functionally Covers Unit Mission, Specified, and Implied Tasks
- Unit Funded by all Sources and Managed to Budget
- Initial O&O Demonstrates Robust Capability to Support Soldier and Army

"Any Soldier, Anywhere, All the Time"

Back Up

Life Cycle Management Concept Guiding Principles

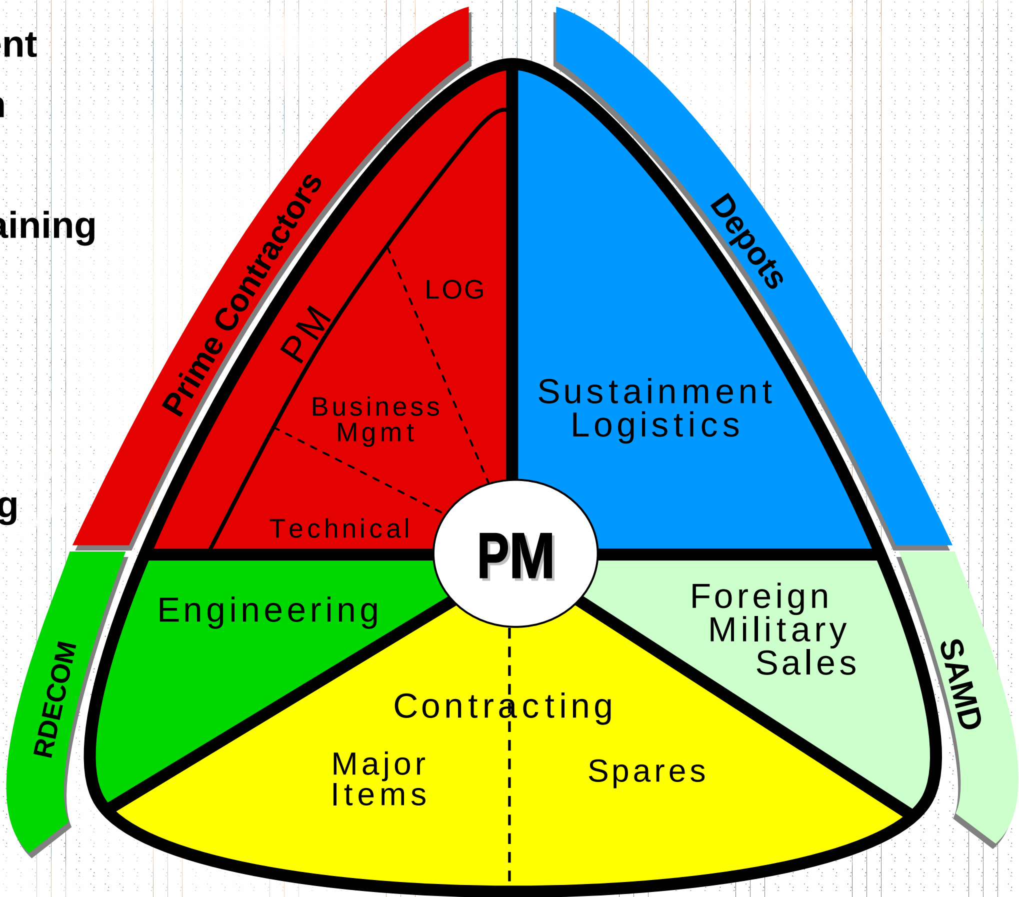
- We are Results Oriented and Warfighter Focused
- People are Paramount
- We Resolve Issues at the Appropriate Level
- Our Partnerships are Agile, Responsive, Streamlined
- We Emphasize Leadership Not Management
- Our Culture is Collaborative, Interdependent, and Based on Open Communication
- We Improve and Integrate Our Business Practices
- We Reduce Bureaucracy and Hierarchy
- We Align Responsibility, Authority, Funding, Evaluation and Compensation
- Integrated Teams are the Cornerstone of Our Organization
- Metrics will Focus on Improving Quality, Reducing Cost, Meeting Schedule, Balancing Risk, and Our Responsiveness to the Warfighter

Our Joint Product is Army Warfighting Capability

PM is the Total Life Cycle System Manager

- Program Management
- System Development
- System Acquisition
- Testing
- New Equipment Training
- Materiel Fielding
- Engineering
- Configuration Management
- System Engineering
- Air Worthiness
- Safety
- Quality
- Industrial Base Planning
- Technical Data Management

PM is “*Trail-Boss*”



- Supply Support (CL V, VII, IX)
- Maintenance Management
- Technical Publications
- Provisioning
- Depot Maintenance
- Packaging
- Transportation
- War Reserves
- Mobilization Planning
- Logistics Assistance
- Readiness
- Case Development
- Case Execution

Acquisition Planning • Contracting • Contracting Management

ASP Description (Mission and Concept)

Mission

Provide the Soldier with Superior Technology and Logistic Support to Meet the Requirement for Close and Long Range Tactical Fires

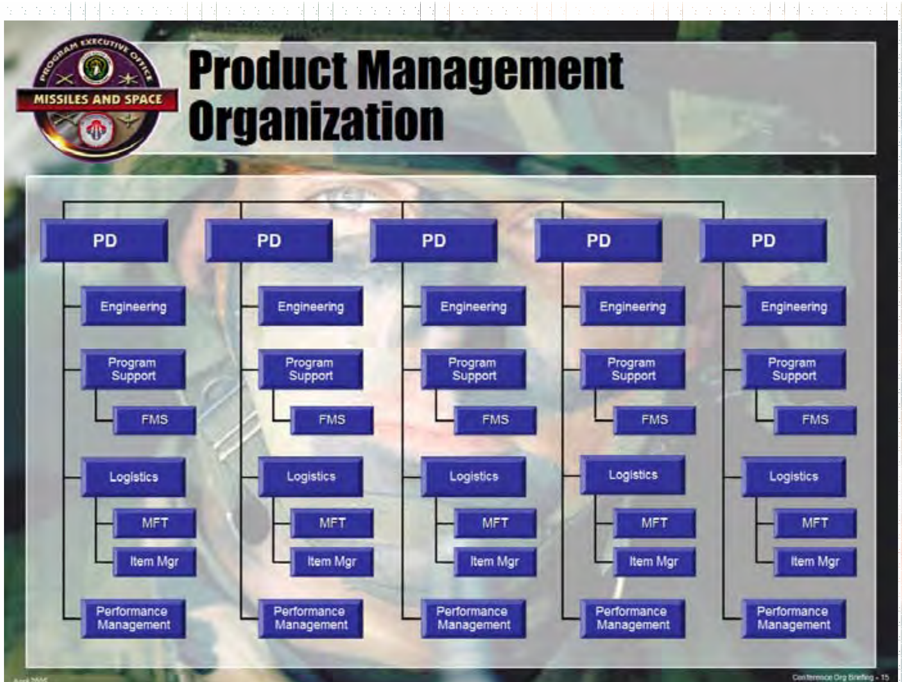
Concept

– Provides a More Streamlined Organization with All PDs Reporting Directly to the Deputy for Acquisition and Sustainment.

– Two Divisions Which Provide Business and Sustainment Capabilities to Entire Organization and the PDs Specifically.

– Deputy Maintains Control of Technical and FMS Advisors to Ensure that Programs are Being Executed in Accordance with Sound Concepts and Meet the Requirements.

Product Management Organization Description (Mission and Concept)



Mission

- Responsible for Cost Schedule and Performance of Assigned Weapon Systems
- Execute APB of Assigned Program(s)
- Resolve all Sustainment Issues

Concept

- Deputy for Acquisition and Sustainment Support Provides Resources and Missions, per Army Program Objectives, to Product Directors who Execute Budget, Contracts, Technical Direction, and Integrated Logistic Support to Execute the Life Cycle Management of their Assigned Program.
- Responsible Management Official for Assigned Program.
- Manage all Resources, Cost, Schedule, and Performance. Provides Assessments of Risk and Contract Performance.
- Responsible to Meet the Requirements Described by the User.
- **The PD is the Problem Solver for all Assigned Program Issues *(Single Belly Button).***

Analogy

- This is the Acquisition and Sustainment Programs PMs. These PMs have the Same Scope and Authority as Chartered PMs with the Addition of Sustainment Requirements Added

O&S Division Description (Mission and Concept)

Mission

– Provide Day-to-Day Status of System Readiness

– Provide Immediate System Support as Needed

– Plan and Analyze Current and Future Sustainment Needs

Concept

Provides Essential Data Elements and Preliminary Analysis for all ASP Programs and all External Linkages.

- **Operations Branch**

  Provides the Day-to-Day Status and Monitoring of the Readiness of Fielded Systems. All Linkages to Both Field Organizations, Logistics Agencies, and Higher Headquarters.

- **Field Support Branch**

  Provides Direct Interface with Fielded Units to React to Immediate Needs. Provides the Coordination and Initial Contact for all ASP Interactions with Field Units.

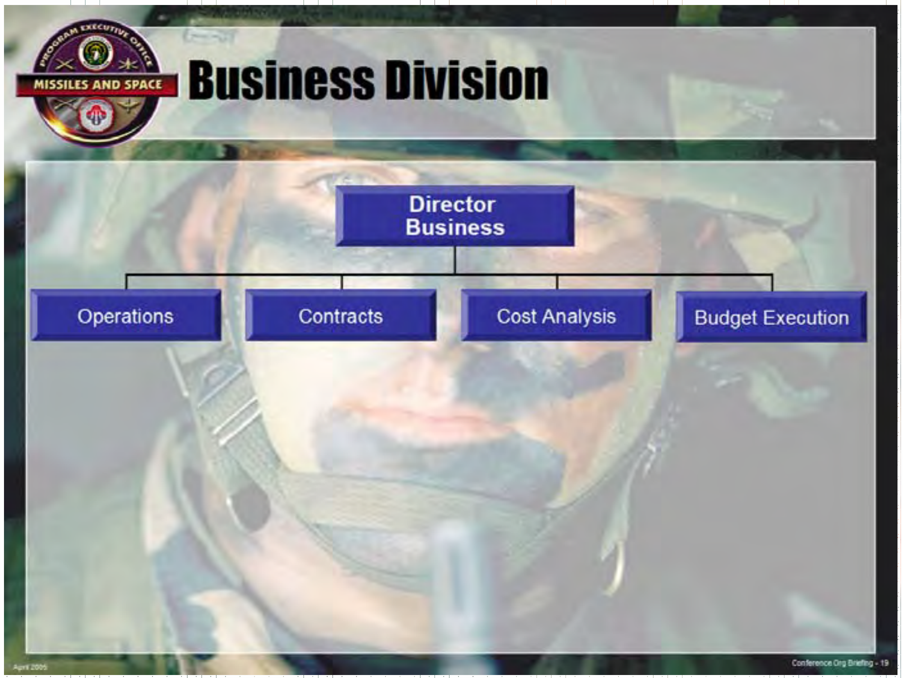
- **Sustainment Support Branch**

  Provides Long-Term Sustainment and Analysis as Well as Common Functions and Specific Sustainment Support Programs.

Analogy

Operation Support is a Similar Concept to a G3 (Operations and Near-Term Planning). Sustainment Support is Like a G5 (Future Plans). Field Support Provides the Forward Support Function Analogous to an FSB.

Business Division (Mission and Concept)



Mission

- Provide all Business Functions for ASP
- Provide Direct Support to PDs in the Execution of their Assigned Programs
- Provide Daily Interface with PEO and HQDA on Acquisition Matters

Concept

Provides Day-to-Day Capabilities, Expertise, and Execution for PDs to Conduct their Assigned Weapon Systems Management Requirements. Provides all Business Functions for all ASP.

- **Operations**

  Provides for all the Daily Interface on all Budget Matters, Other Taskers, and Acquisition Reporting Requirements.
- **Contracts**

  Provides for all Contract Management and Execution Necessary for PDs and/or any Other ASP Needs.
- **Cost Analysis**

  Provides Cost Analysis Support for all Programs and Sustainment Requirements.
- **Budget Execution**

  Provides for Execution of Current Funds in Support of MIPA, RDTE, OMA, SSTS, AWCF, Direct Cite, and Reimbursable in Support of PDs and Other Organizational Elements.

Analogy

The Business Division has Almost 100% Commonality with Current PM Business Divisions with the Addition of Sustainment Fund Management.

Estimated Funding Sources and Allocations