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International Infantry & Joint Services
Small Arms Systems Section Symposium, Exhibition & Firing Demonstration

13-16 May 2002

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.
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Pocket Laser Rangefinder Update by William Dunnill & Jos van Seeters, Leica Technologies Inc.



STOCK OPTIONS FOR THE WARFIGHTER

NAVSEA
CRANE

DAVE ARMSTRONG -

WEAPONS BRANCH

WEAPONS DEPARTMENT

ORDNANCE ENGINEERING DIRECTORATE

NAVAL SURFACE WARFARE CENTER

CRANE DIVISION

STOCK OPTIONS FOR THE WARFIGHTER



AK-47 “Carbine” vs. M14 Rifle

STOCK OPTIONS FOR THE WARFIGHTER



STOCK OPTIONS FOR THE WARFIGHTER



Army Stock vs. Standard Colt M4

STOCK OPTIONS FOR THE WARFIGHTER



Basic Enhanced Stock w/ Component Parts

STOCK OPTIONS FOR THE WARFIGHTER



Enhanced Stock with Issue Colt Stock

STOCK OPTIONS FOR THE WARFIGHTER



STOCK OPTIONS FOR THE WARFIGHTER



Maybe not for “every” rifle out there ???????
Does show adaptability of the M4 stock though

STOCK OPTIONS FOR THE WARFIGHTER



M1014 Combat Shotgun - In Service w/ USMC

STOCK OPTIONS FOR THE WARFIGHTER



Side Folding M14, Type 56(AK), Mossberg 500A1

STOCK OPTIONS FOR THE WARFIGHTER



HK G36A3 Compact, MP5K, Sig 552 Commando - All with Side Folding Stocks

STOCK OPTIONS FOR THE WARFIGHTER



M4A1 Carbine w/ Enhanced Stock & ACOG 4X

STOCK OPTIONS FOR THE WARFIGHTER

NAVSEA CRANE



“Iron” Sights



Reflex Sight

HK MP-7 PDW (Personal Defense Weapon)
Shown with stock retracted and extended -
Essential for medium range engagements

STOCK OPTIONS FOR THE WARFIGHTER



10” M4 Suppressed w/Enhanced Stock vs. AK-47

STOCK OPTIONS FOR THE WARFIGHTER



Valmet Model 82



IMI Tavor TAR-21



STKinetics SAR-21



Vector CR-21

STOCK OPTIONS FOR THE WARFIGHTER



M14 Sniper, M24 Stock, .300 Win Mag Sniper

STOCK OPTIONS FOR THE WARFIGHTER



STOCK OPTIONS FOR THE WARFIGHTER

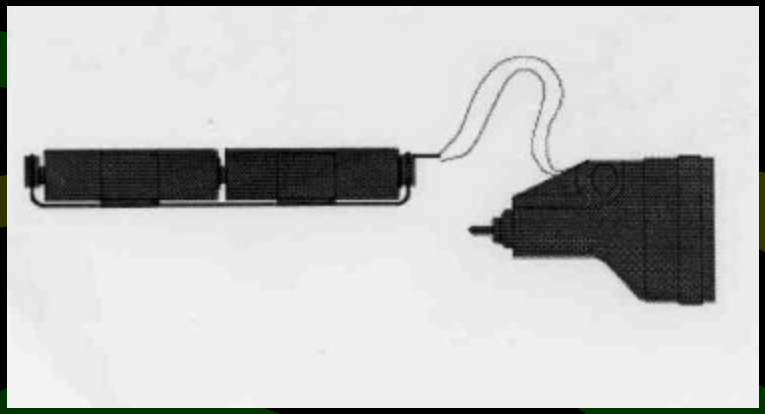


STOCK OPTIONS FOR THE WARFIGHTER

NAVSEA CRANE



SAR-21 with Integral Laser in Forestock

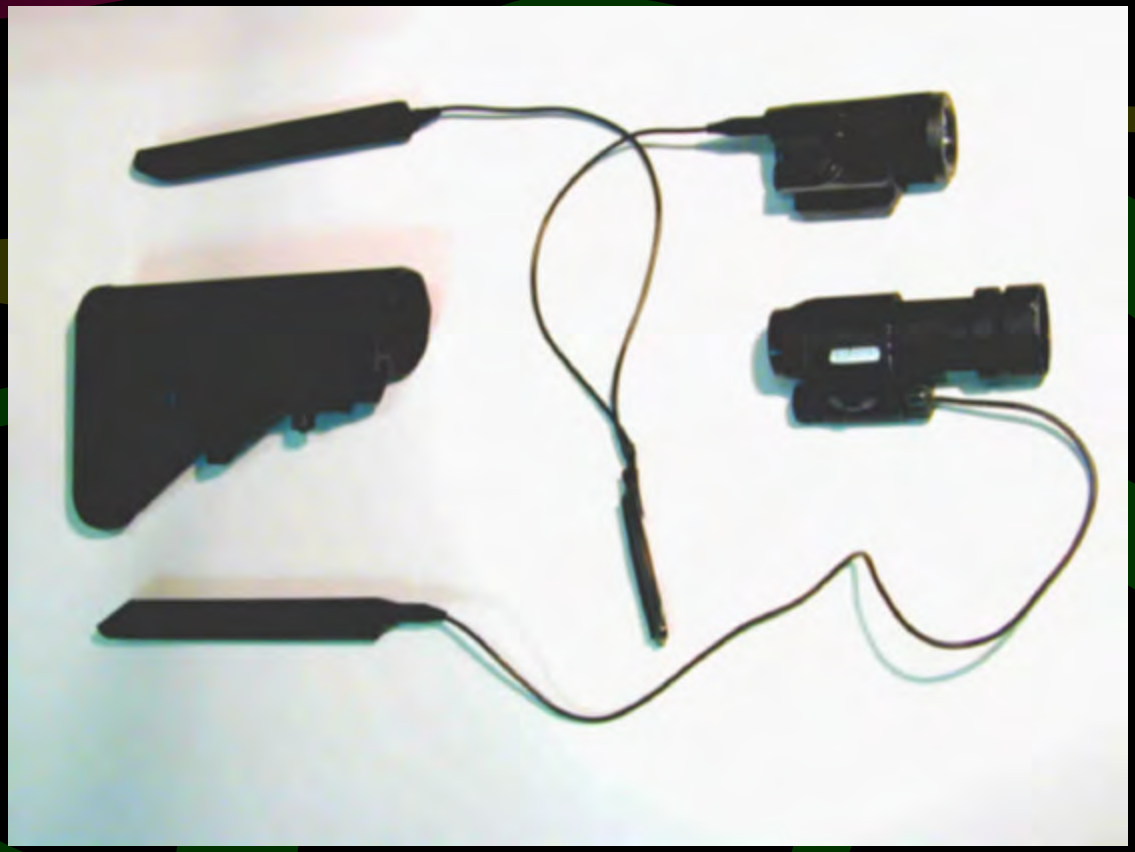


KEL-TEC SUB 2000 Carbine Light Configuration - Battery Pack housed in Forestock



Polish PM-98 SMG Forestock integrates Laser or Light replaceable with fold-down pistol grip

STOCK OPTIONS FOR THE WARFIGHTER



Basic Power Pack Concept w/ Light and AimPoint

Project Manager Soldier Weapons

Mr. Richard G. Audette
Deputy PEO Soldier
(Acting)

The Threat

PM Soldier Weapons has responded to the changing threat emphasized by the end of the cold war. The two primary types of warfare with the greatest near term priority are:

- Remote hostile environments (Afghanistan)
- MOUT

PM Soldier Weapons has responded to the transformation of the Army through its support of the Objective Force involving the following initiatives:

- OICW
- OCSW
- OFW
- Legacy Systems

War on Terrorism

Actions taken by PM Soldier Weapons to support the war in Afghanistan:

- Three urgent material releases of the XM107 cal .50 Long Range Sniper Rifle
- Out of sequence (accelerated) fieldings of the Modular Weapons System (MWS)
- Supplied six types of non-lethal ammunition included in the urgent material release of non-lethal capability sets
- Provided technical assistance to units getting ready to deploy
- Supported increased M249 SAW replacements due to war related increases in training and preparation for deployment
- Procuring medium machine guns and grenade machine guns for use by other DOD elements

Actions taken by PM Soldier Weapons to support Homeland Defense:

- Procuring rifles, pistols, carbines and medium machine guns for use by Law enforcement and other DOD elements

Transformation

- **OICW – fielded to Land Warrior in FY07. Land Warrior Block III becomes Objective Force Warrior in FY08**
- **OCSW – transitions to PM Soldier Weapons in FY04. Candidate secondary armament for FCS**
- **OFW – working with JSSAP to transition to PM SOLDIER WEAPONS in FY05 Fielded in FY08**
- **Legacy Systems – modernizing/improving to defeat changing threat**



Questions?

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raudette@pica.army.mil

TACOM

Lethality, Survivability, Mobility and Sustainment for America's Army

OBJECTIVE CREW SERVED WEAPON

Original OCSW ATD Technology Objective

Define, Develop And Demonstrate a Lightweight, Two-man Portable, Ground Mounted Crew Served Weapon System with High Explosive Air Bursting Capability Out to 2000 Meters

Mr. Glen Berg
ATD Manager, OCSW
DSN 880-6906
COM: (973) 724-6906
Email: gberg@pica.army.mil

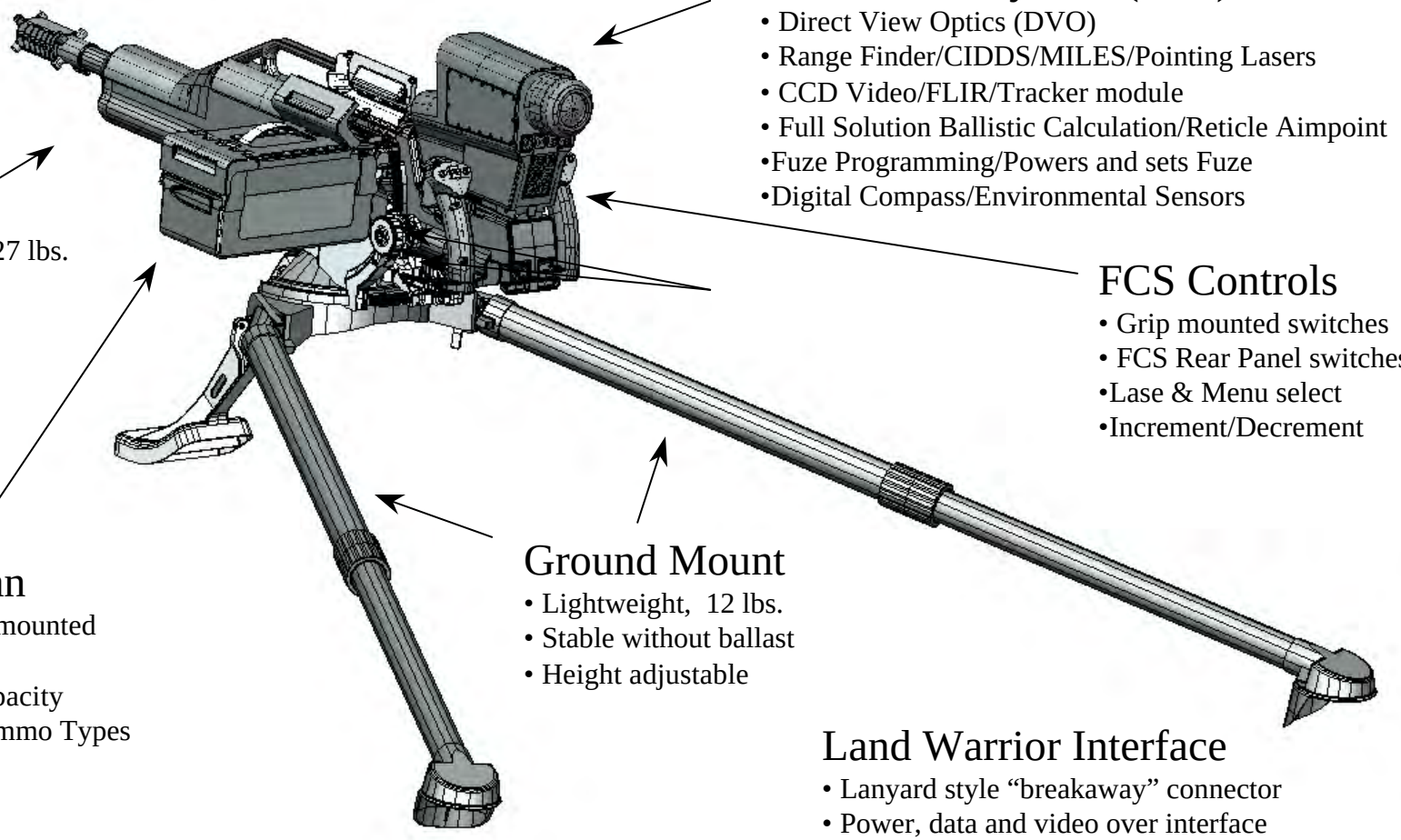
OCSW SYSTEM

Muzzle Device
•Flash Suppression
• Inherently Reliable

Fuze Setter Contacts

Fire Control System (FCS)
• Direct View Optics (DVO)
• Range Finder/CIDDS/MILES/Pointing Lasers
• CCD Video/FLIR/Tracker module
• Full Solution Ballistic Calculation/Reticle Aimpoint
•Fuze Programming/Powers and sets Fuze
•Digital Compass/Environmental Sensors

Weapon
• Light Weight, 27 lbs.
•25mm, 220 spm
• Soft Recoil
• Gas Operation



FCS Controls
• Grip mounted switches
• FCS Rear Panel switches
•Lase & Menu select
•Increment/Decrement

Ammo Can
• Right or left mounted
• Linked Belt
•31 Round Capacity
•All OCSW Ammo Types

Ground Mount
• Lightweight, 12 lbs.
• Stable without ballast
• Height adjustable

Land Warrior Interface
• Lanyard style “breakaway” connector
• Power, data and video over interface
• Compliant to LW requirements



Camp Pendleton Firing Video Clip

Revolution in Small Arms Performance

Future Capability

Revolutionary!

OCSW Equiv. Performance Weight

Max Effective Range (25 mm):
- Defilade Target to 1,000 m
- Area Targets to 2,000 (8 men 10 m x 50 m)
- Airburst, Point Detonation (PD) & Self Destruct Capabilities
- Defeats Targets in Defilade
- Armor Piercing Round 2" HHA/RHA



OCSW - 64 lbs



M240 MG - 64.8 lbs



7.62mm KE Ball & Tracer

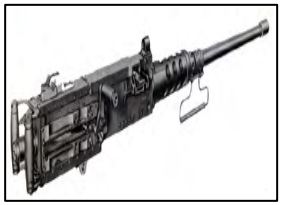
31 X

98%

Airbursting Munitions



OCSW Airburst



M2 50 cal. HMG - 171 lbs



.50 cal KE Ball, Tracer & SLAP

50X

37%



Mk19 Grenade MG - 208.5 lbs



40mm HE (M433)

13 X

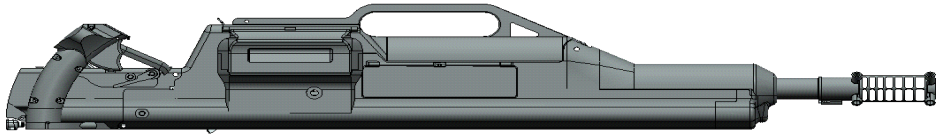
30%

Weight = Weapon & Ammo

Evolutionary

Current Capability

Weapon Initiatives



- **Simplified receiver casting -** Production Investment Cast aluminum construction
- **Parts Reduction -** 283 parts versus 500 (Mk19) and 397 (M2)
- **Reliability Testing -** Rounds Fired to Date: 10,266
- **Impulse Averaging Soft Recoil System –**
  - Barrel Returns to Same Location After Every Shot
  - Mass not Required to Stabilize Gun
- **Ammunition Velocity Correction System –**
  - Compensates for Round-to-Round Velocity Variation
  - Increases Airbursting Accuracy



OCSW Fire Control

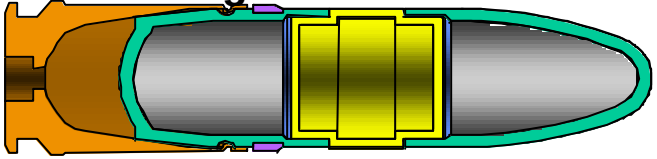


- Full Solution Fire Control
  - 2.2 km range performance
  - ±1 meter laser rangefinder
  - Ballistic processor
  - Single reticle
  - Fuze setter
  - Digital compass
  - Embedded training
  - MILES/CIDDS
  - Thermal Interface
  - Direct view optics 5x9.5° FOV
  - Land Warrior ready
  - Full FOV laser steering
  - Motion tracker

OCSW BALLISTIC MATCHED 25mm AMMUNITION FAMILY

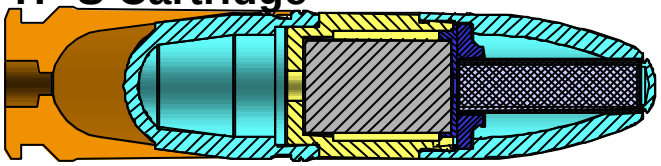
- Aluminum Cartridge Case
- Standard Ball Propellant
- Standard Percussion Primer

HE Cartridge



- Precision Air-Bursting @ 2K
- LX-14 High Explosive
- Defeats PASGT Vest & Helmet
- Controlled Fragmentation Warhead

TP-S Cartridge

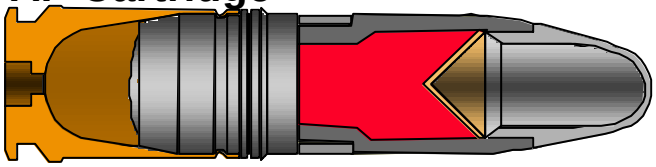




Mini Electronic Time Fuze w/ Point Detonating/Self Destruct Capability

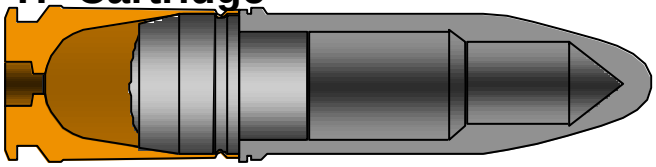
- Flash Bang Training

AP Cartridge



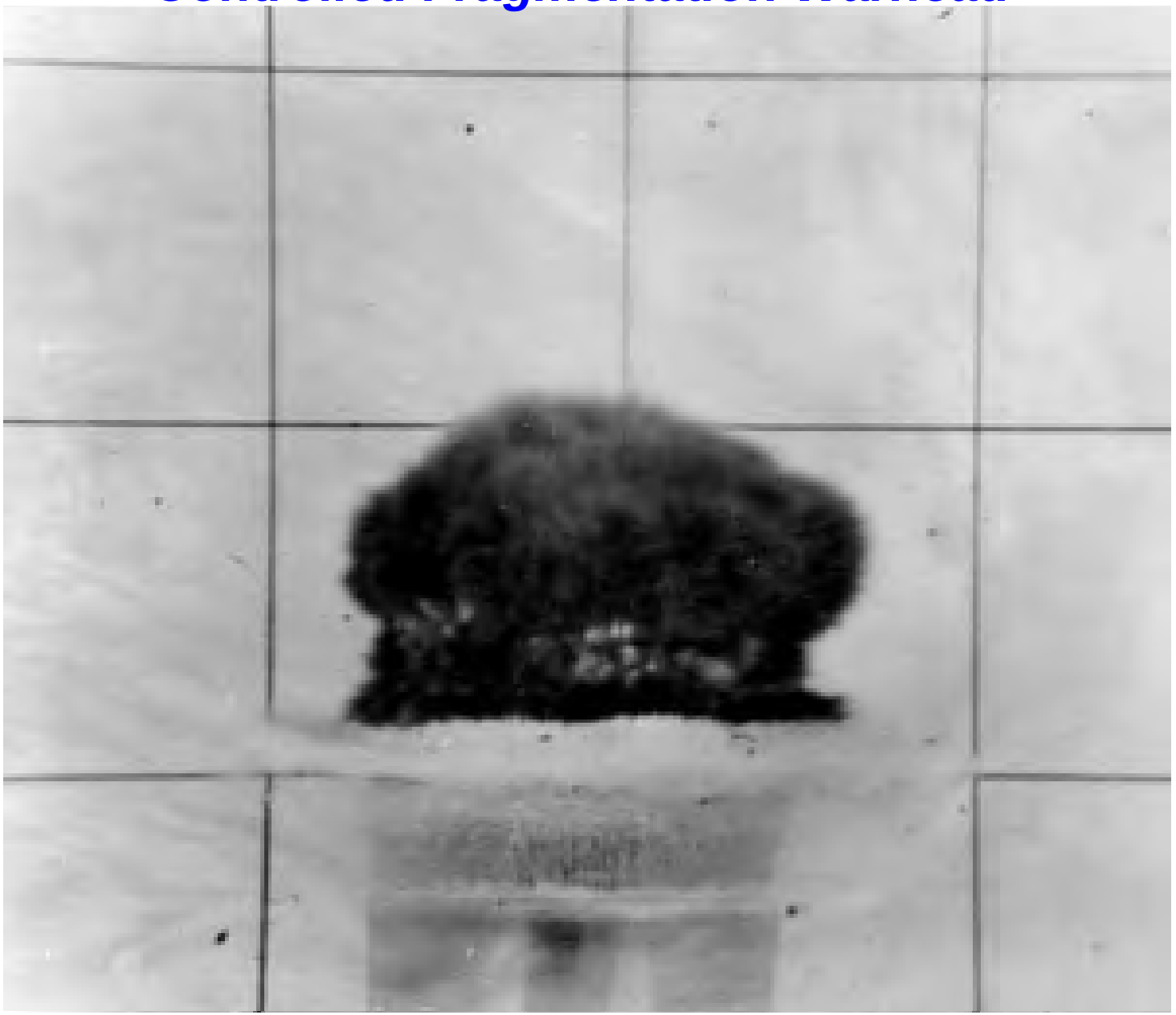
- 51mm RHA (Threshold)
- 51mm HHA (Goal)

TP Cartridge

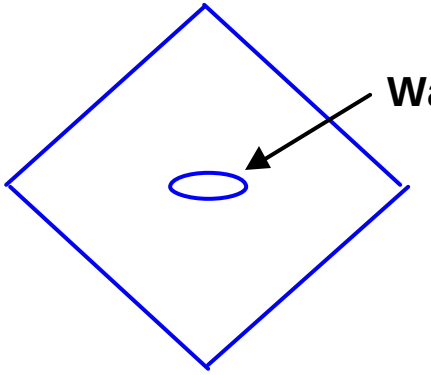


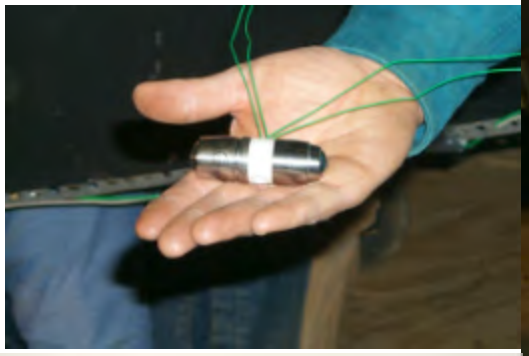
- Two-Piece Projectile
- Integral Rotating Band

Controlled Fragmentation Warhead



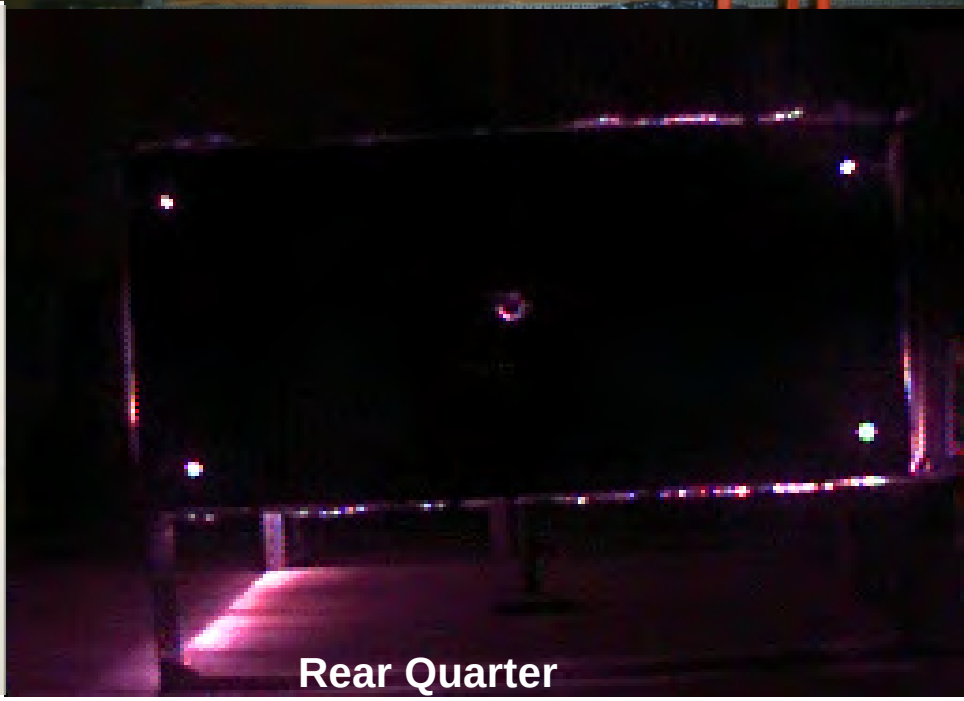
Fragmentation Tests

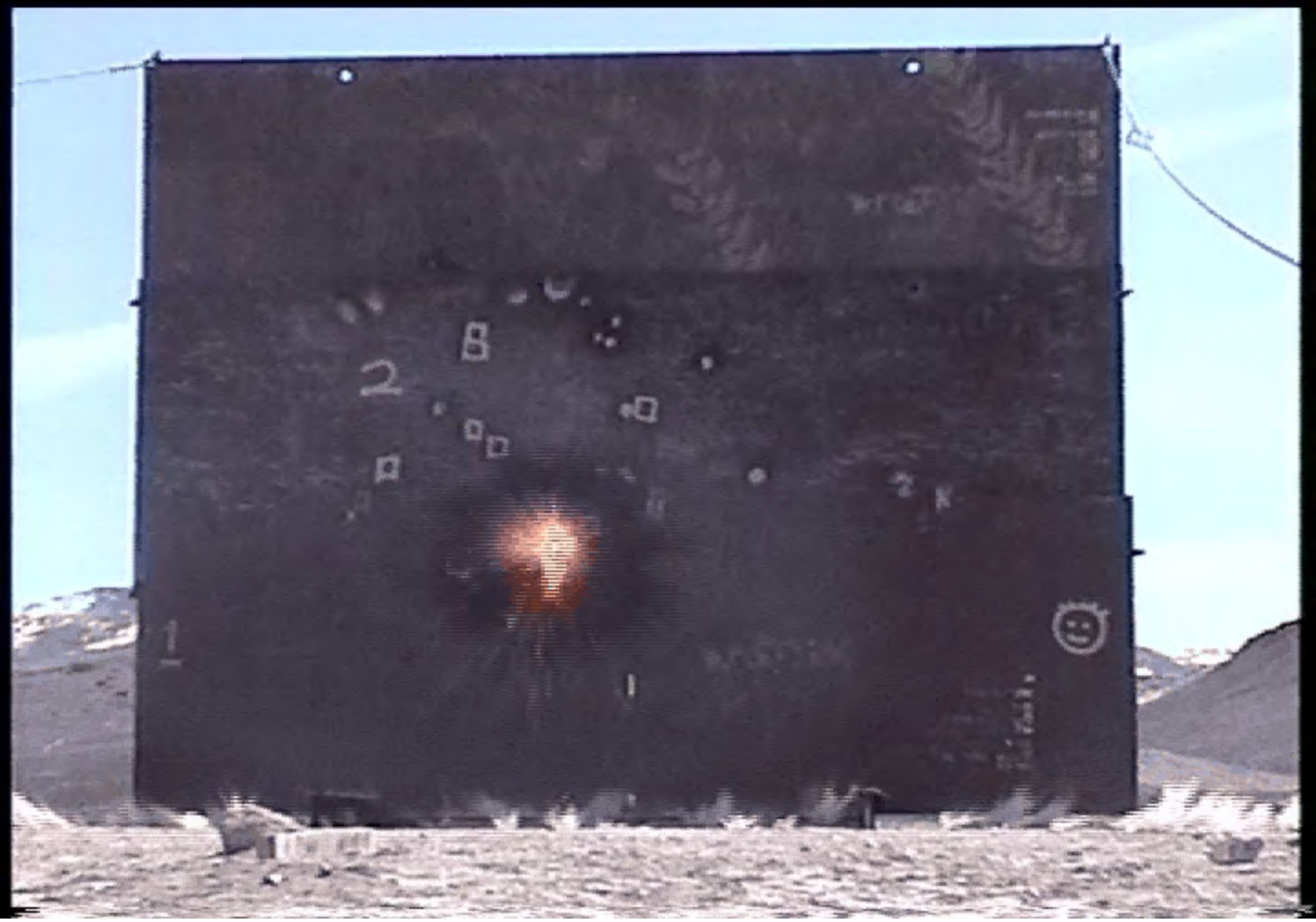












ATD Status - Accomplishments

- Fired remotely at 5 successful System Integration Tests

- Demonstrated TA/FCS target ranging and ballistic solution calculation

- Demonstrated ability to feed Ballistic solution to ammo-fuze at 250 rounds per minute

- Demonstrated velocity correction capability

- Demonstrated ammunition airburst accuracy (<4 meters at 600 meters)

- Demonstrated weapon reliability growth (100 MRBS)

- Demonstrated armor piercing capability

First Manned Firing
26 April 2002



OCSW As Remotely Operated Secondary Armament

Programs Expressing Interest in Remote Operation:

- ✓ Future Combat Systems
- ✓ Future Tactical Truck Systems
- ✓ Active Protection System
- ✓ Multi-Role Ammunition Armament System
- ✓ Crusader
- ✓ Abrams
- ✓ US Coast Guard Deepwater Program
- ✓ Unmanned Combat Armed Rotorcraft

OCSW As Remotely Operated Secondary Armament

Integration Tasks for Remote Operation:

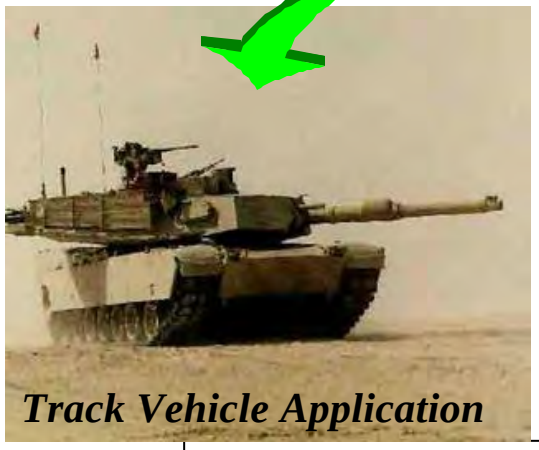
- ✓ Add Solenoid For Remote Firing
- ✓ Route Cable And Integrate Weapon Controls With Operator's Station
- ✓ Provide Fire Control Display And Controls At The Operator's Station
- • Identify & Select Stabilized Mount
- • Install Large Capacity Ammo Container On Mount
- • Add Actuators And Resolvers For Laying OCSW Independent Of Main Gun



Potential Armament in Common Remote Operated Weapon Station (CROWS)



Candidate Secondary Armament for Future Infantry Vehicles



Track Vehicle Application



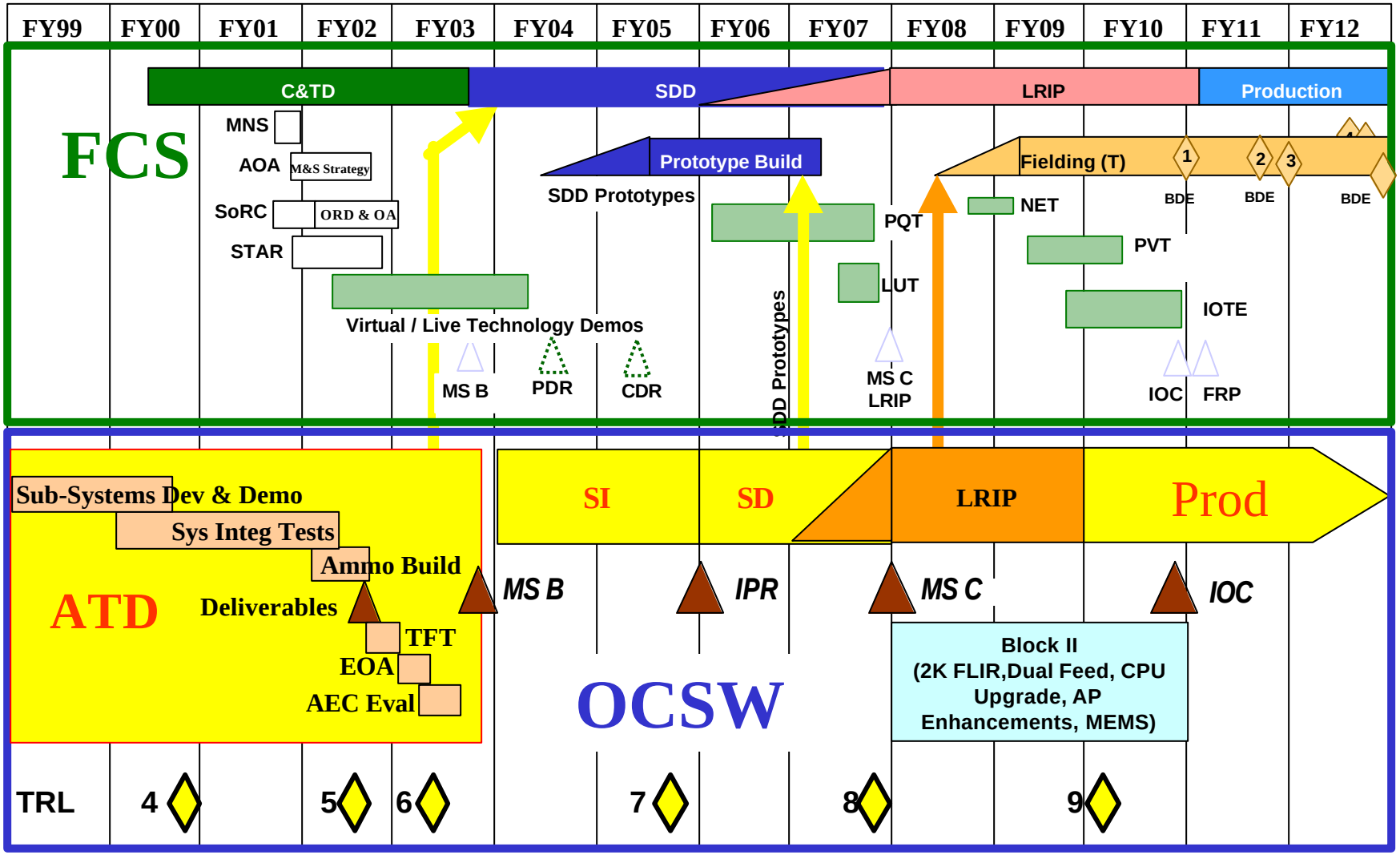
Potential Application as Defensive Armament for Crusader SPH and RSV

Objective Crew Served Weapon System LSI Discussion

- OCSW on All Vehicles Except Commander Vehicle and Recon Vehicle (Med Cal Cannon) in Proposed Baseline
- OCSW MS B to be a part of FCS MS B (Align MS B on Charts)
- OCSW Should Continue ORD and AoR, AoA included in FCS AoA



Tie-in with FCS Schedule



OBJECTIVE CREW SERVED WEAPON SUMMARY

- ATD Technologies On-Track to Meet Exit Criteria
- PM On-Board for Transition Planning
- Work On-Going to Close Gap Between ORD and Exit Criteria
- OCSW is Prime for Vehicle Applications



2002 International Infantry & Joint Services Small Arms Systems Section Symposium, Exhibition & Firing Demonstration

« 21st Century Military Operations and Technology »

May 13-16, 2002

BRIAN BERGER
CHAIRMAN
SMALL ARMS SECTION

SNC TEC SIMUNITION

2002 NDIA INT'L INFANTRY & SMALL ARMS SYSTEMS SYMPOSIUM

- **Administrative Announcements**
  - Live Fire Demonstration – Ft. Dix N.J.
  - NJ National Guard
  - Sal Fanelli
  - John Resch
  - Ft. Dix Personnel
- **Int'l Infantry / Small Arms Committees**

SNC TEC SIMUNITION

2002 NDIA INT'L INFANTRY & SMALL ARMS SYSTEMS SYMPOSIUM

- **Agenda**
  - 80 + papers submitted
  - 67 papers selected
  - Special thanks to:
    Jim Lamb, Frank Puzychi, Dennis Conway, Joel Goldman, Steve Faintich
- **Exhibitors**
  - Floor Space Sold Out
  - Visit Exhibitor Booths
- **Conference Evaluations**
  - Complete Evaluations
  - Return to NDIA

SNC TEC SIMUNITION

2002 International Infantry & Small Arms Symposium

21st Century Military Operations and Technology

Objective Force Warrior

15 May 2002



Philip Brandler
Director,
Natick Soldier Center

Natick Soldier Center

Soldier System Paradigm Shift

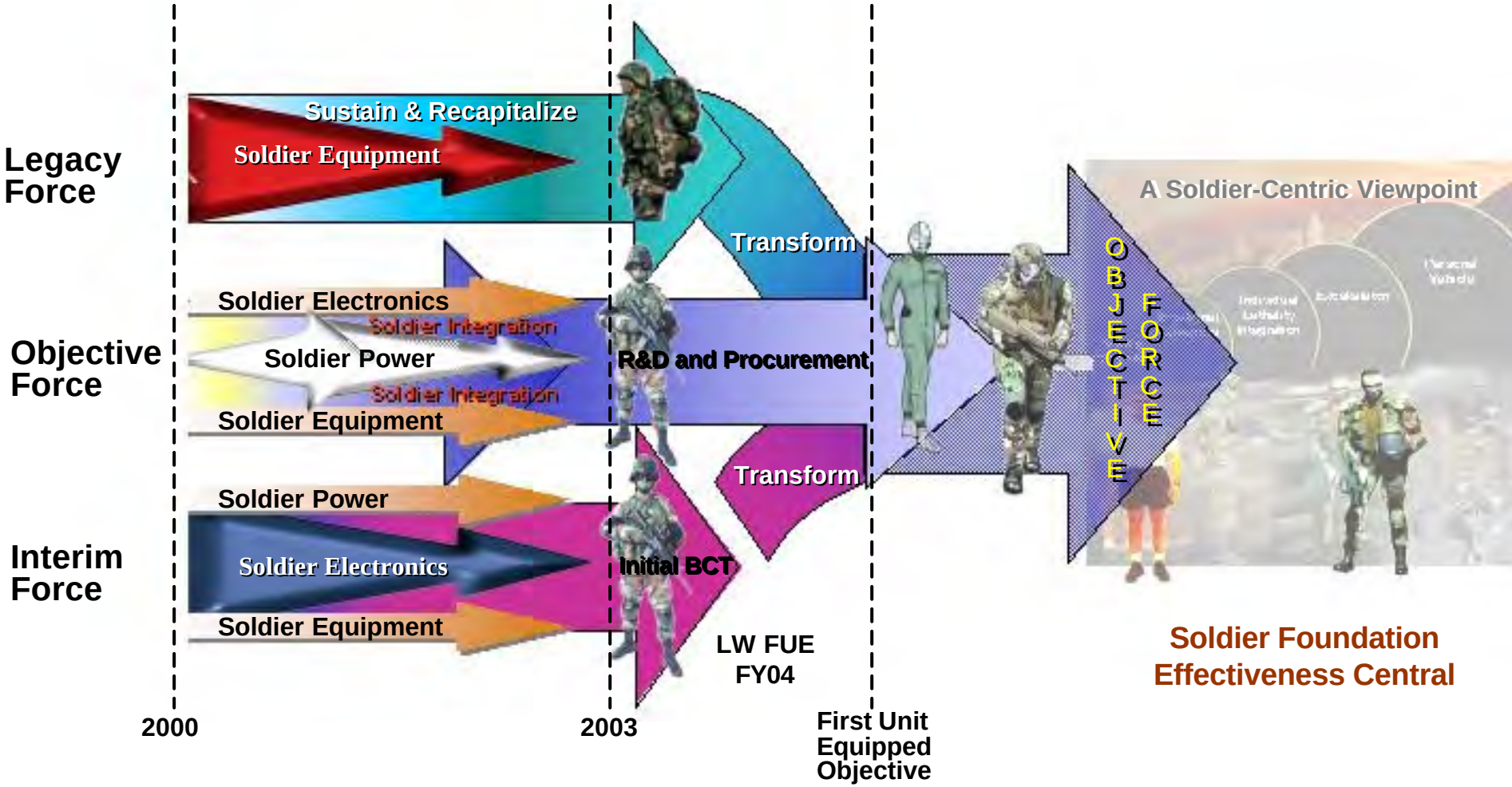




…Christmas Tree

…Integrated Human-Centric System

Soldier Systems in the Army Transformation

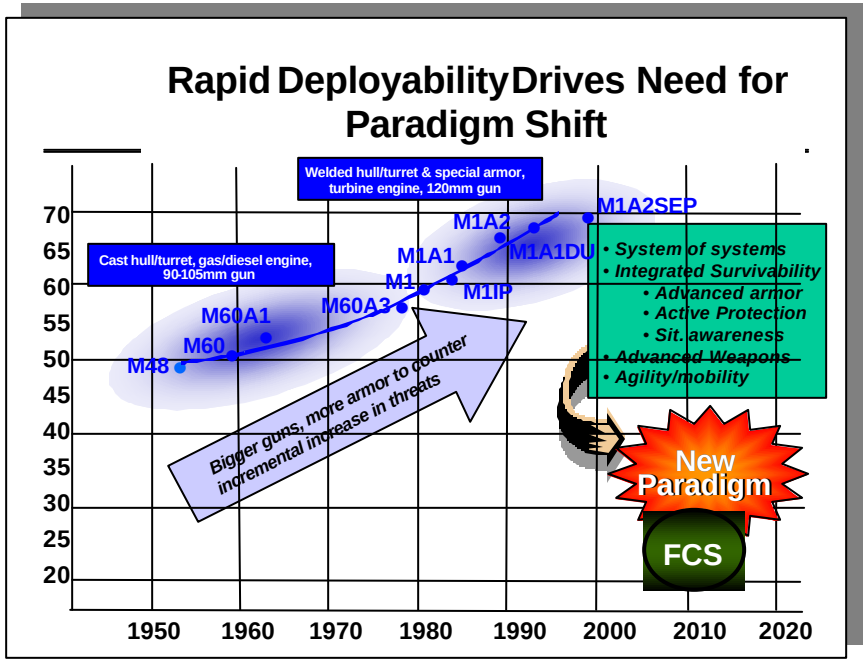


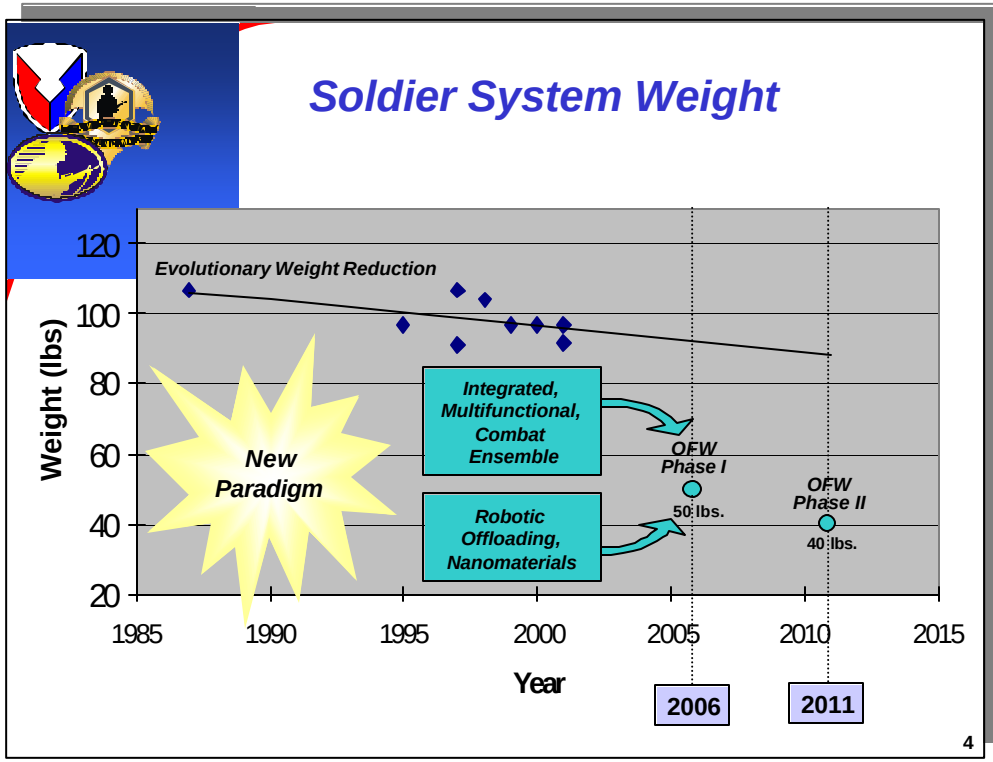
Soldier Foundation Effectiveness Central

Soldier Systems are Centric to Army Transformation

FCS Thinking Extends to Soldier Systems

Unprecedented agility and empowerment of soldiers in FCS and OF concepts drives need for a Paradigm Shift





Five Independent Study Panels on Objective Force Warrior

OFW Independent Review Team

OFW Special Study Group (SSG)

Army Science Board (ASB) Summer Study on OFW

Oak Ridge Visioning Teams

FCS Technology Assessment Panels

Including TRADOC TSM-Soldier

THE RESULTS

250+ Leading Experts from Ind, Gov & Acad

Consistent Vision & Message

- ✓ Major Technology Investment Needed
- ✓ Revolutionary Improvements over LW Possible
- ✓ Initiate Flagship Objective Force Warrior System of Systems Integration Program
  - – Milestone B No Earlier than end of FY06 (as late as FY08) for Leap Ahead

Conducted Between Oct 2000 and Nov 2001

IRT View of S&T Investment in the Warrior System

Current Warrior S&T Investment is approximately 5% of the Army S&T Budget…

- **Sufficient to meet the needs of the "Soldier-Centric" Objective Force?**
- **Comparison: FCS investment is 35% of the Army's S&T**
- **Similar challenges face future warrior systems…**
  - **Increased protection at a lighter weight**
  - **Greater lethality at a reduced weight**
  - **More enduring power sources**

IRT Findings & Recommendations

Findings:

- The S&T program can yield revolutionary soldier performance in this decade *if* the program is *redefined/re-resourced ($300-400 M over the POM)*

Recommendations:

- To achieve a revolutionary capability in this decade:
  - Initiate a *flagship* Objective Force Warrior program NOW
  - Develop revolutionary warrior system design by following FCS Program strategy

Revolutionary Soldier Performance Requires Aggressive, High Risk Actions



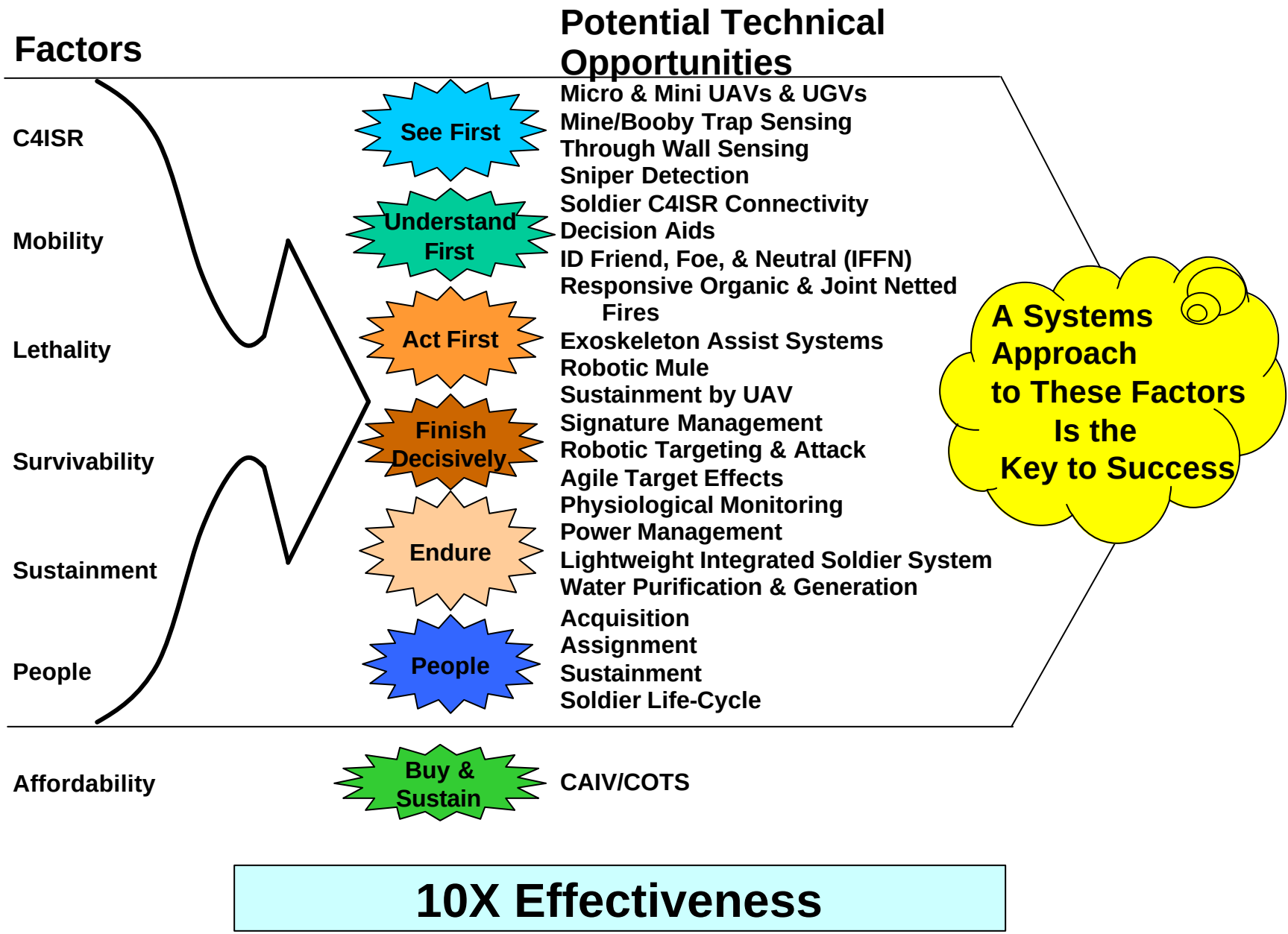
SUMMER STUDY 2001

Land Warrior – A Success Story

- It works
- Dramatic cost reductions
- Big gains in effectiveness
- The LW Team deserves high praise

- However, significant challenges remain:
  - Fightability
  - Weight
  - Power
  - Affordability
  - Systems Approach

Toward Achieving the Goals

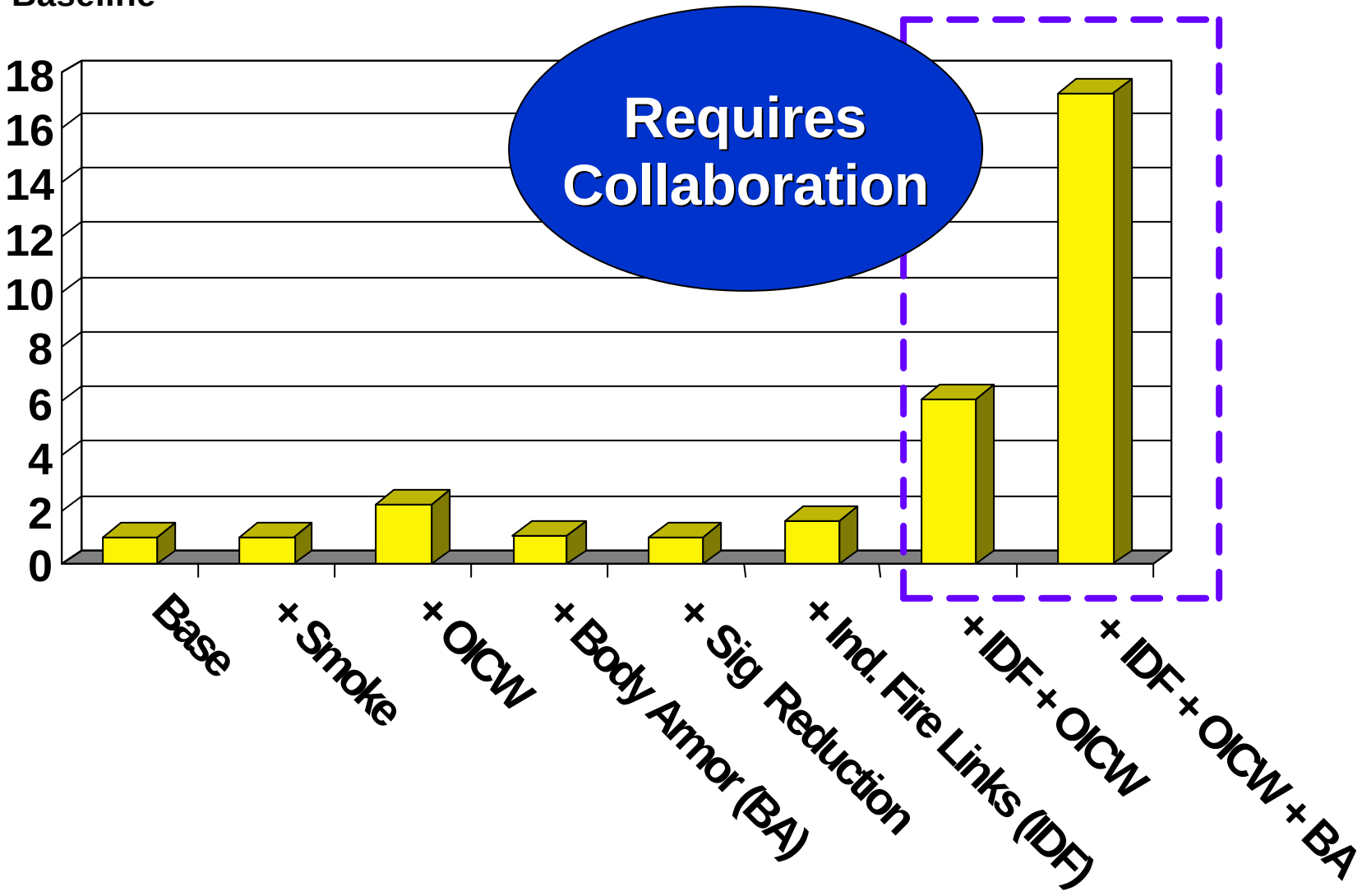


10X Effectiveness

SUMMER STUDY 2001

Alternative Options Show Significant Improvement

LER Improvement Over Baseline

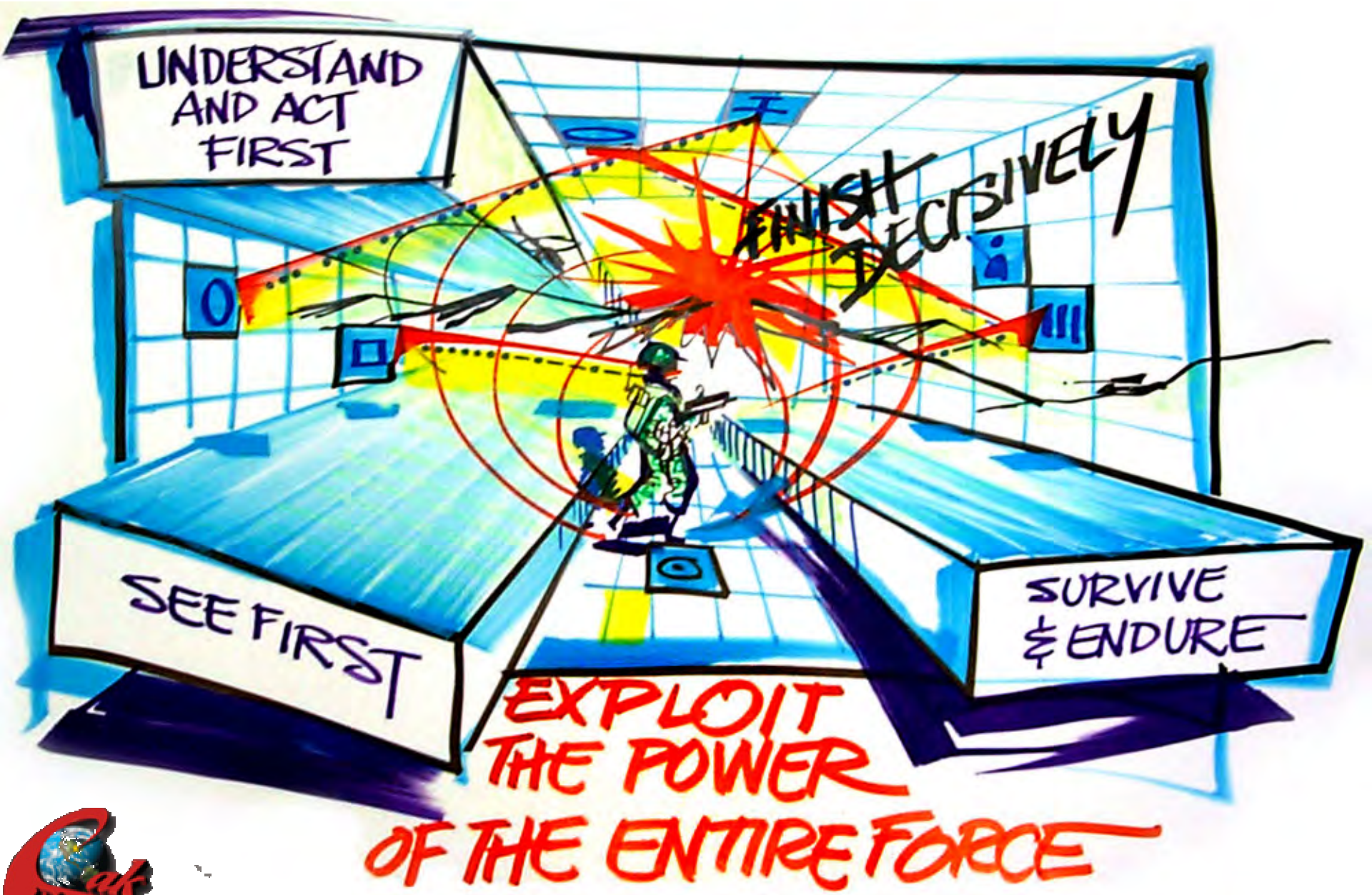


Mid Term Recommendations
Objective Force Warrior
(TRL7 by 2008 – FUE by 2012)



Collaborative

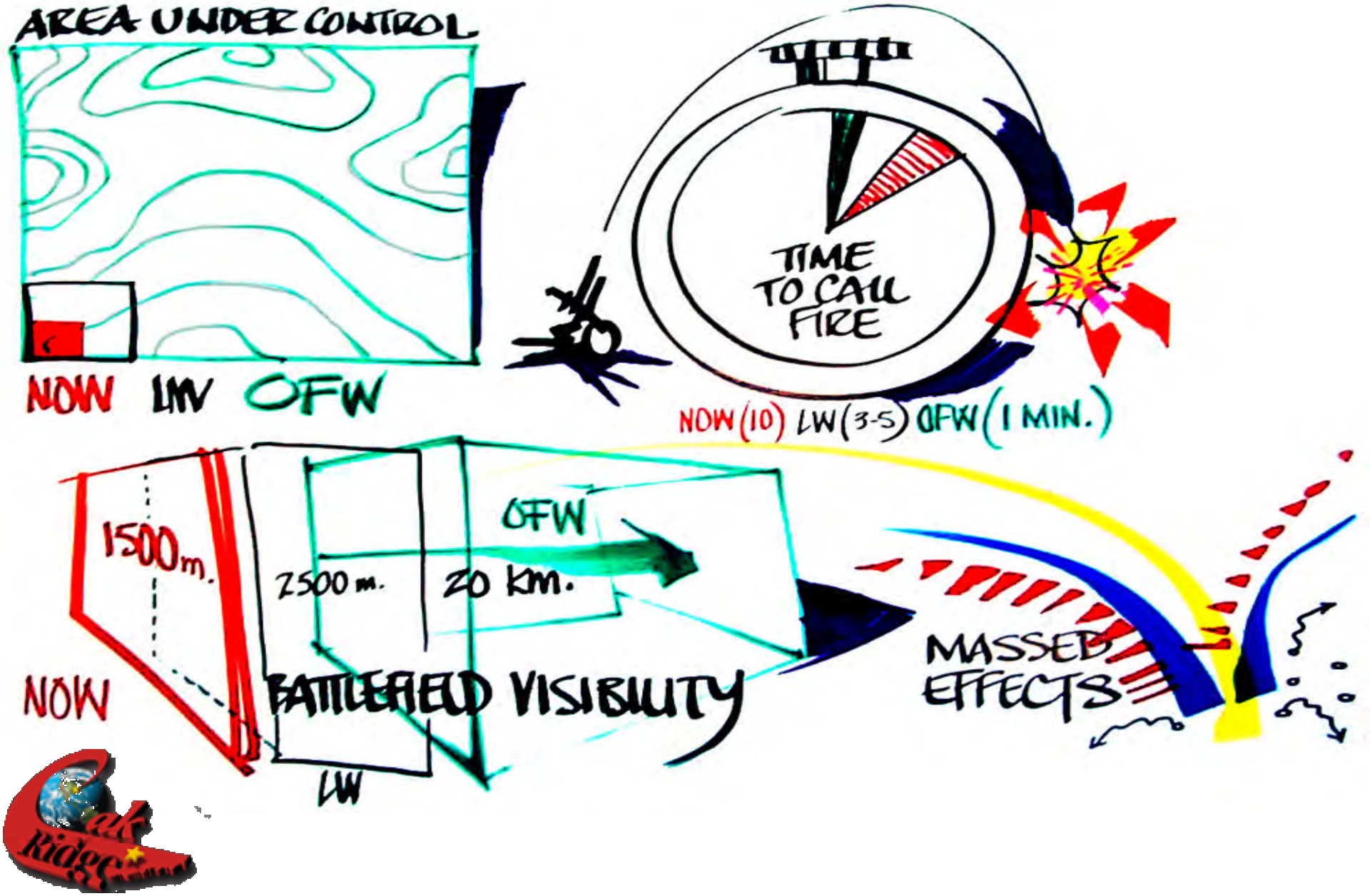
SUMMER STUDY 2001

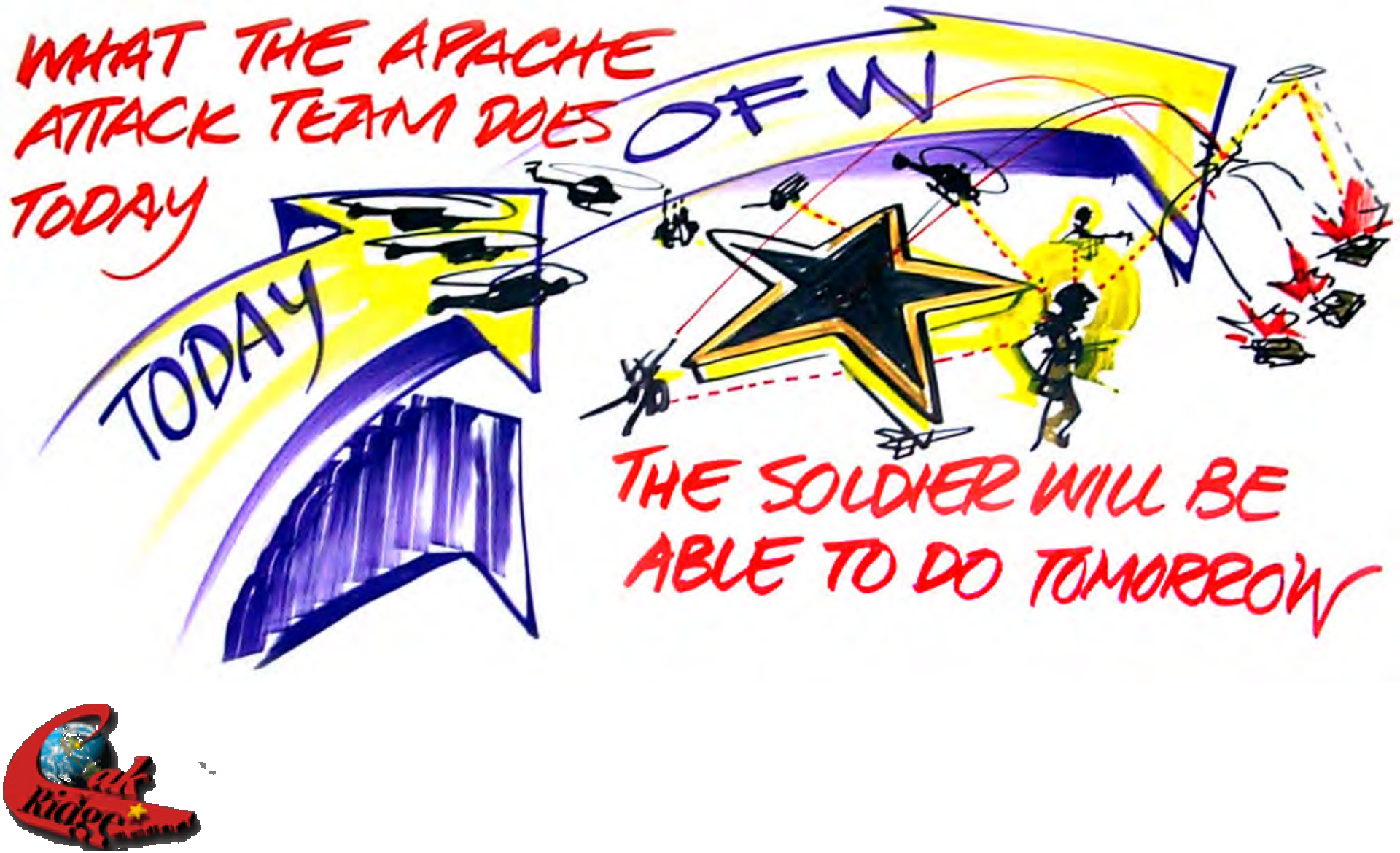

UNDERSTAND AND ACT FIRST
FINISH DECISIVELY
SEE FIRST
SURVIVE & ENDURE
EXPLOIT THE POWER OF THE ENTIRE FORCE

VISION — Essential Principles

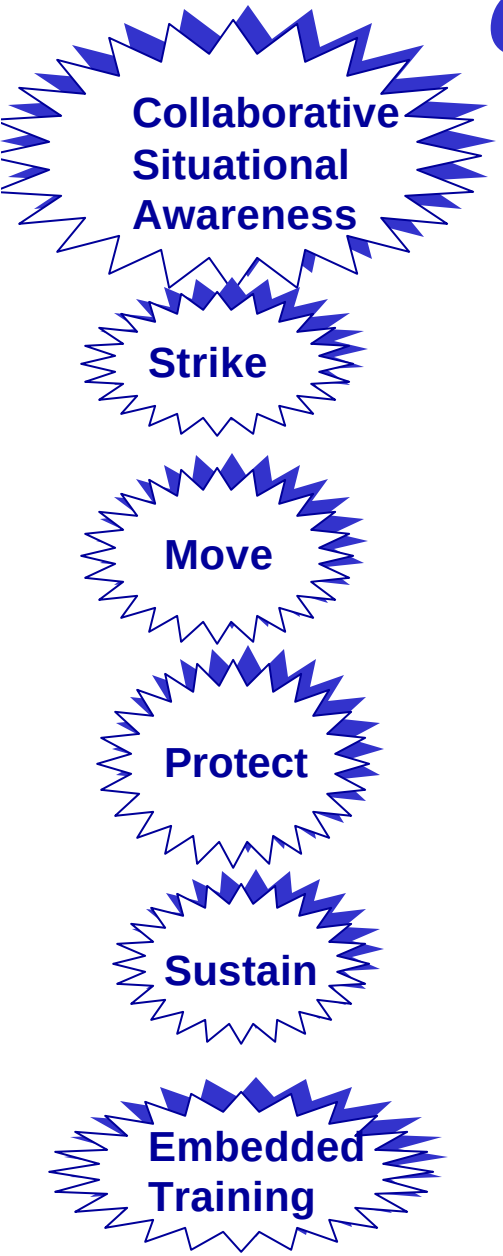
- "Overmatch" for the Soldier
  - Dominate with Information
- Apply the Power of the Force
  - Collaborative massed effects
- Three-dimensional Aspect of Effects
  - Vertical integration
  - Stand-off
  - Expanded Area Under Control
- Warrior Culture
  - Human performance - centric design
  - Extended cohesion
  - Paradigm shifts in recruiting, manning, and training
- Open Architecture
  - Integrate emerging capabilities continuously

BATTLEFIELD CONTROL




WHAT THE APACHE ATTACK TEAM DOES TODAY
TODAY
OFW
THE SOLDIER WILL BE ABLE TO DO TOMORROW

"MUST HAVE" OFW COMPONENTS



- **Collaborative Situational Understanding**
  - **Netted Communications**
- **Apply/Mass FCS Combat Multipliers to Overmatch**
  - **OCSW critical**
- **Reduce Weight**
  - **UGV load-carrier now**
  - **Lighter equipment technologies**
- **Individual Survivability**
  - **Protective equipment**
  - **Integrated combat ensemble**
- **Power**
  - **Advanced fuel cell**
- **Training Integration**

EXPONENTIAL LEAP-AHEAD POSSIBLE BY 2018

Optimized Situational Understanding
- Netted Commo
- Netted Fires
- Intelligent Agents

Next Generation Power Source

Advanced Robotics
- Sensors
- Load Carriers
- Fighting Functions
- Exoskeleton

Next Generation Weapon

Smart Bullets

Overwhelming OVERMATCH

Integrated Fighting Ensemble
- Full Ballistic Protection
- Nanotechnology Materials
- Total Environmental Management
- Very Fightable

Optimized Performance-Centric Design
- Training
- Neural
- Medical
- Rations

More Options to "Close With" and "Destroy"

EQUIPMENT DEVELOPMENT THOUGHTS

- Keep It Small and Simple
- Spiral Development (Deploy with Tech Teams for first units)
- Field by Unit Sets
- Economically Producible in Quantity
- Open Architecture to Maximize off the Shelf (Moore's Law)
- Modular Mission Payloads (Soldier and Vehicle)
- Minimize Logistics Tail
- OFW Lead System Integrator Linked to FCS Integrator

SUMMARY

The Old Wisdom Endures	—	Move, Shoot, Communicate, Along with Survive and Endure, Still Wins
The Future Champion	—	Netted Communications Leading to Situational Awareness, Collaboration, Massed Effects, Sensing, and Synergy is the Key to the Future
The Over-Arching Gestalt	—	Exploit the Power of the Entire Force
Four Technology Imperatives	—	Information, Power, Miniaturization, and Robotics
The Urgent Cry	—	Passionate Call for a “MULE” like Tool
The “OTHER FORCE”	—	The Human-centric Battlefield Dynamics of the WARRIOR CULTURE are Key Combat Multipliers

OFW
Special Study Group (SSG)

- **SSG Direction:** Established (‘01) by ASA(ALT) to address IRT recommendations
  - Define a vision, investment, and acquisition strategy for Warrior Systems for the Objective Force
- **SSG Composition:**
  - Co-Chaired by Dir, NSC and TSM Soldier
  - Composed of members of the Soldier related technology community, including NSC, ARDEC, CERDEC, MRMC, TARDEC, ARL, ARI, STRICOM
  - Included TRADOC and Users

OFW SSG Process
Premised on Warfighter Needs

- Derived warfighter needs for OFW from key Transformation documentation
- Brainstorm capabilities for each need
  - Users and developers
  - Warfighter SME panel banded capabilities
- Broad-based technology inquiry to ID technologies for capabilities to meet needs

- OFW Needs not yet Vetted or Prioritized by Headquarters TRADOC

OFW Needs Grouped into Capability Areas

Lethality - Direct and indirect engagement; less than lethal engagement; target detection/recognition; synchronization of fires; target handoff; ID friendly/ enemy/non-combatants; target designation

C4I - Situational Understanding; information management; comms; enhanced vision/senses; detect/avoid hazardous areas; area denial; mark items of interest; intel collection & dissemination; mission planning/rehearsal

Power Sources - High Density, lightweight, efficient, safe, reliable power (hybrids, rechargeable)

Analysis & Assessment - Modeling tools to enable optimal system development and assessment; virtual prototyping; individual and force on force modeling



Survivability - Full spectrum individual protection; signature management; thermal management; physiological status monitoring

Mobility - Horizontal, vertical mobility; reduce/offload equipment carriage; ID/reduce/defeat obstacles; position/location/tracking

Sustainability -Delivery of tactical resupply; water purification/generation; water management

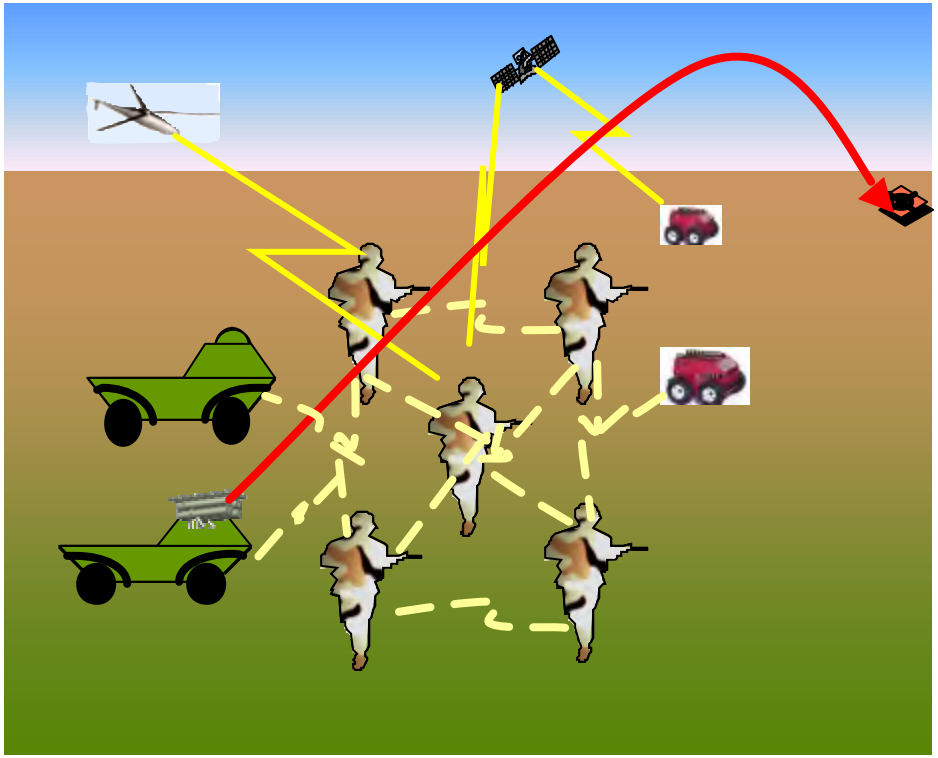
Training - Individual, small unit, leader training concepts; embedded training, novel TTPs to exploit OFW capabilities

Human Performance - Sustain and enhance Individual and team performance; optimize system and team fightability; optimize human endurance, cognitive and physical capabilities

System Engineering and Integration -Integrate all technical areas into comprehensive, integrated system of systems; weight, power, and cost treated as independent variables

OFW Capabilities Create A Formidable Warrior……

….In an Invincible Team

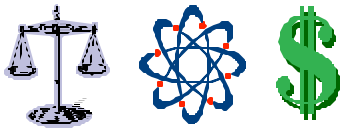


- **A combined arms force at the fire team level**
- **C4ISR Provides leap-ahead overmatch effectiveness**
  - Collaborative real time planning and execution
  - Coordinated LOS and BLOS fires and movement
- **Robotic "Mules," "Dogs" and "Eagles" provide**
  - Remote sensing
  - Mobility
  - Sustainment
  - Lethality

Many Revolutionary Capabilities Are Within Our Reach

Technology & Systems Integration

Systematic Incorporation of Revolutionary Technologies



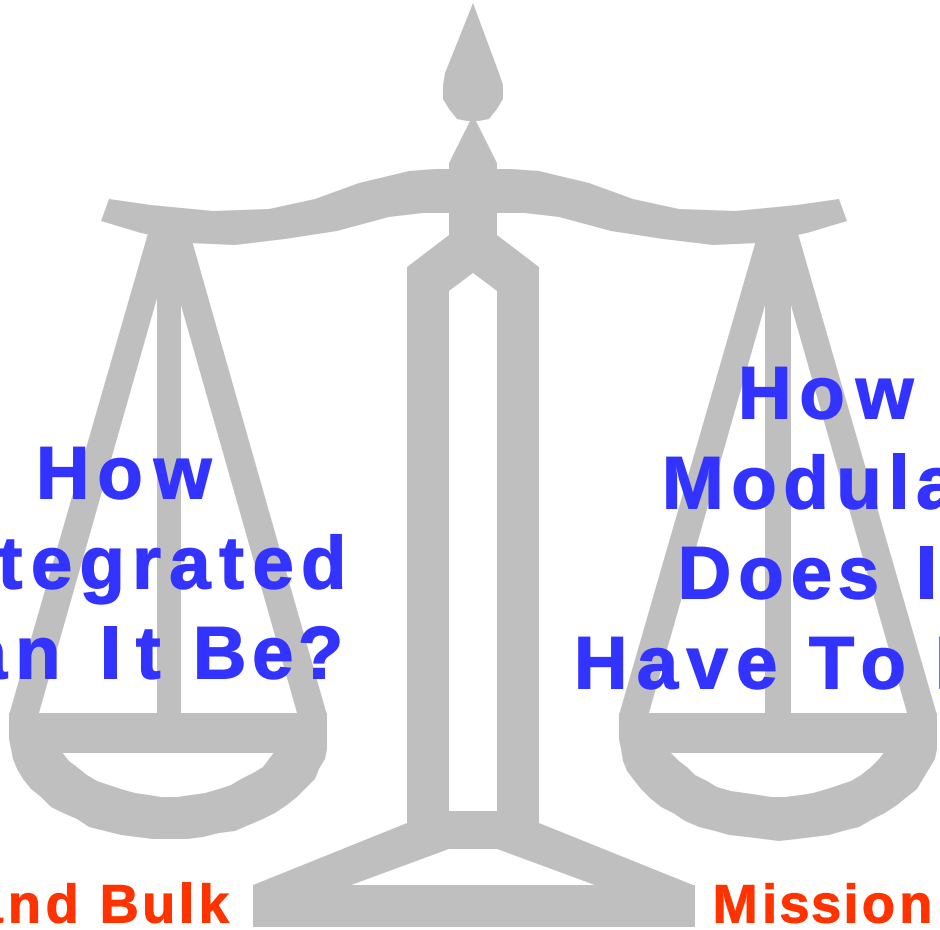
Balance Weight, Power, Cost & Performance

Human Performance & Integration

- **Integrated Process Product Development & Integrated Product Teams**
  - ***Maximizes Developer, Producer, User Interaction & Produces the "Best" System***
- **Holistic System Design Approach**
  - ***Maximize Human / System Performance***
- **Robust Analysis & Assessment**
  - **Leverage Government Modeling & Analysis Tools**
- **Synchronize with Objective Force Systems (e.g., FCS, C^3 on the move, Networked Sensors)**

Program Structured to Leverage both DoD & Marketplace Technology

Finding the Balance



How Integrated Can It Be?

How Modular Does It Have To Be?

Weight and Bulk

Mission Flexibility
Technology Upgrades

Combat Ensemble -
The Chassis for Technology Integration

Physical Interfaces & Integration

Electronic Interfaces & Integration



Human Interfaces & Integration

Software Interfaces & Integration

Interfaces & Integration Both Within and External to Chassis

Human Centric System Architecture

The Objective Force Warrior Program

A Revolutionary Capability For The Objective Force



- **Scope: All Combat Warriors within Objective Force Unit of Action**
- **Diverse, Large Scale Integration Program Structured to Leverage cutting edge Technologies from both Government & Industry**
  - **Currently in S&T Phase**
- **System of Systems Concept Tailored to Maximize Effectiveness of Team of Teams Operations**
- **Synchronized/Compatible with FCS**

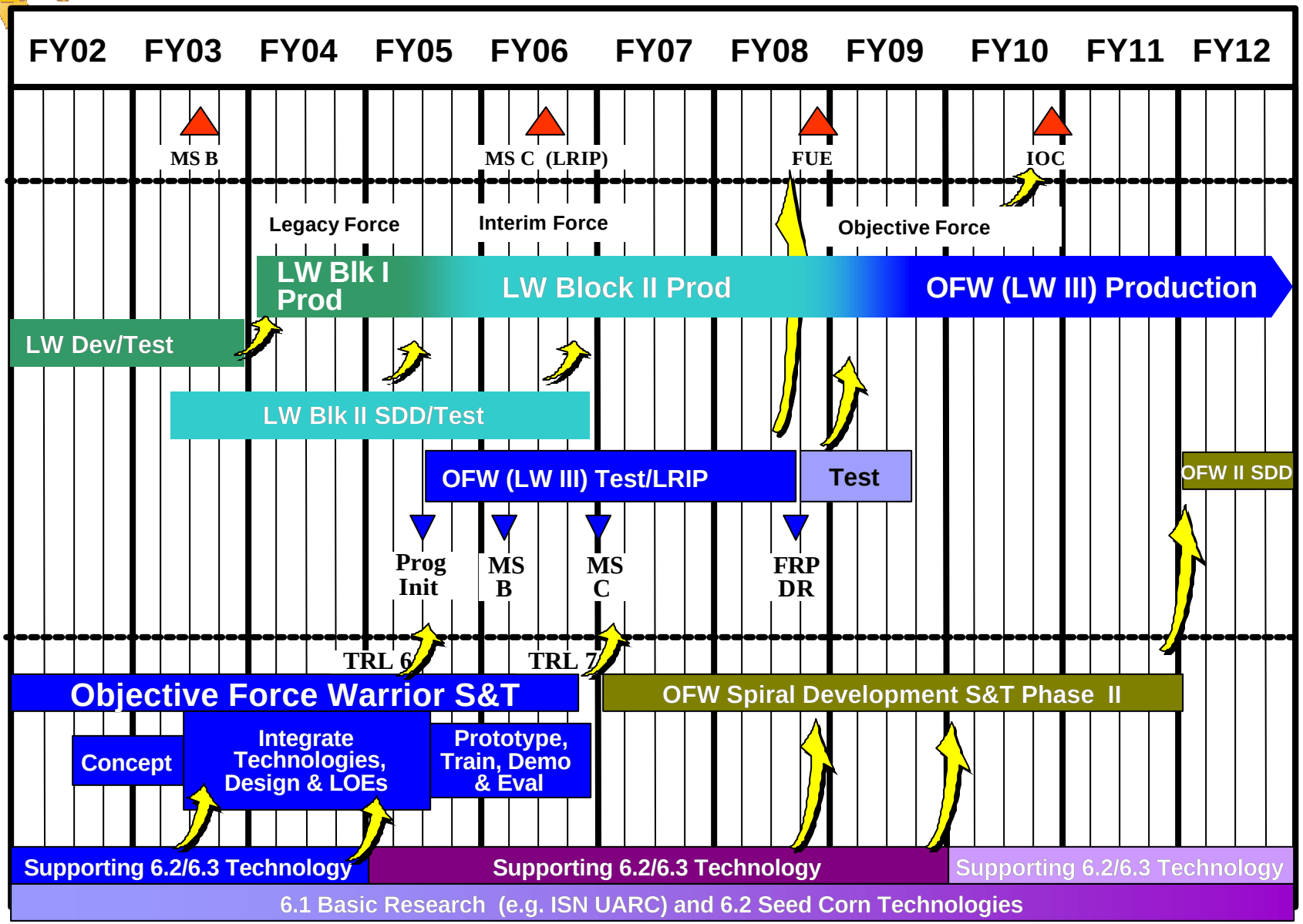
Planned Technologies for Objective Force Warrior

- Near Real Time Fire Synchronization
  - Netted FCS Fires
  - OFW Direct & Area (w/ HE from OICW, OCSW)
- Ultra-Light Grenade Launcher, Kinetic Energy (KE) Combat Rifle, Machine Gun & Ammo (Block II)
  - Integrated Multi-Spectral Fire Control
- Hybrid Fuel Cell Energy Systems
  - Reduced Logistics Footprint & Cost
- Compact, Low Power Networking Digital Radio (SUO/SAS ?)
  - JTRS Compatible
  - Voice, Data & Video
- OFW Mobile, Ad Hoc Tactical Network
  - Links Warriors, Mules, & Team UAV
  - WIN-T Compatible for FCS Network Integration
  - Dominant Information & Awareness
- Hybrid All Terrain Navigation
  - 3 Meter, Vertical & Horizontal Accuracy

Planned Technologies for Objective Force Warrior

- Integrated Combat Suit & Headgear
  - Ultra-Light, Novel Integration
  - Full Spectrum Protection
  - Signature Management (Near & Far IR)
  - Directional Long Range Hearing
- Fused Thermal, I^2 Integral with Headgear
  - High Resolution Color Display
- Unmanned Aerial Vehicle
  - Organic to Warrior Team
  - Man-packable and/or Mule Launched
- Robotic Mule
  - Reduce Soldier Carried Weight to 40-50 pounds
- Physiological & Medical Sensors & Algorithms
- Micro-Climate Cooling & Heating
- Customized Voice, Tactile, Visual, & Auditory Human Interface
- Embedded Training & Rehearsal
  - Netted, Collaborative
- Human Performance Enhancements

Accelerated OFW Acquisition Strategy
- Meets FCS FUE in FY08 -



OFW Solicitation Highlights

- Contracting Vehicle “Other Transactions for Prototypes” Agreement
- Bids Received 1 May
- Contract Award Estimated For 15 July
- PEO, TRADOC, OFTF, ARL, ARI, RDEC, STRICOM and MRMC Representation in Source Selection
- “LTI” Concept with two Competing LTIs
- OFW LTIs tied to FCS LSI

Government/Industry Relationships

- ***Government is Leader in OFW Program Decision Processes***
  - ***Government IPT to review, assess and influence competing Lead Technology Integrator (LTI) OFW concepts***
  - ***Full Government participation on LTI IPTs***
    - ***Appropriate firewalls***

- ***Industry Executes OFW Technology Development***
  - ***Takes direction from OFW TPO***
  - ***Develops OFW Concepts, Explores alternatives***
  - ***Executes design, development and fabrication activities***

Goal: LTI and Government Team dedicated to provide best solutions for Objective Force Warrior

Final Remarks

- **Soldier Domain has Historically been Under-Funded**
  - **No Rich Source of Technology Options**
- ***"Demonstrating a high level of maturity before new technologies are incorporated into product development puts those programs in a better position to succeed"****
- ***"It is a rare program that can proceed with a gap between product requirements and the maturity of key technologies and still be delivered on time and within costs"****
- **OFW Strategy is Consistent with:**
  - **Five Independent Panel Recommendations**
  - **Successful Business and Service Practices**

*** 1999 GAO Report: Better Management of Technology Development Can Improve Weapon System Outcomes**

Report to Small Arms Committee

National Defense Industrial Association (NDIA)

Armament Division

2002 Division Status

14 May 2002

Small Arms Committee

Value Added Has Been Demonstrated

Leadership to Strengthen the Small Arms Community

Challenge: Adapting Technology, Systems for Transformation

Ensuring Readiness . . . . Advancing Superior Capability

Purpose

Superior Technology and Systems — Readiness — Affordability

Provide organizational focus to armament systems used by U.S. and allied countries and to address other topics relevant to armament systems

- "Lessons Learned"
- Deficiencies/needs
- Requirements pull/technology push
- Development
- Deployment
- Operations

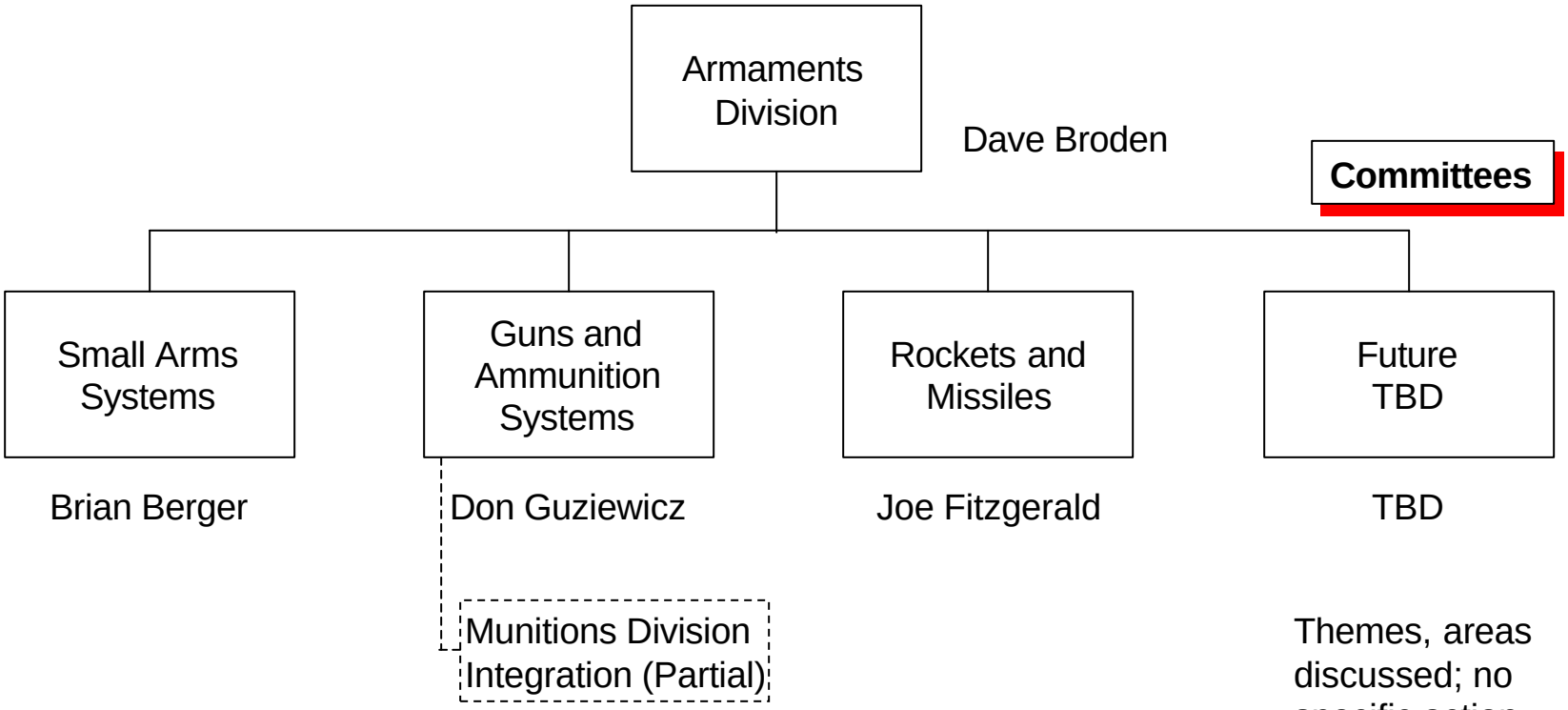
Life Cycle Focus

- International cooperation
- Acquisition
- Affordability
- Supportability

Acquisition Management

Leadership

Objective: Coordinated Focus and Vision for Armament Systems



Scope – Area of Interest – Responsibility Definition Clarity

Seeking Cooperation with Related Sections

Committee Scope

Small Arms Systems

- Individual weapon(s)
- Crew served weapon(s) (e.g., ≤ 40mm)
- Full life cycle
- Supportability
  - Training
  - Logistics
- System integration
- Target Acquisition/Fire Control System (TA/FCS)

Guns and Ammunition

- Medium caliber systems
- Tank systems
- Mortar systems
- Artillery
- Naval gun systems
- Aircraft/helicopter systems
- Platform integration
- System integration
- TA/FCS
- Supportability
- Life cycle

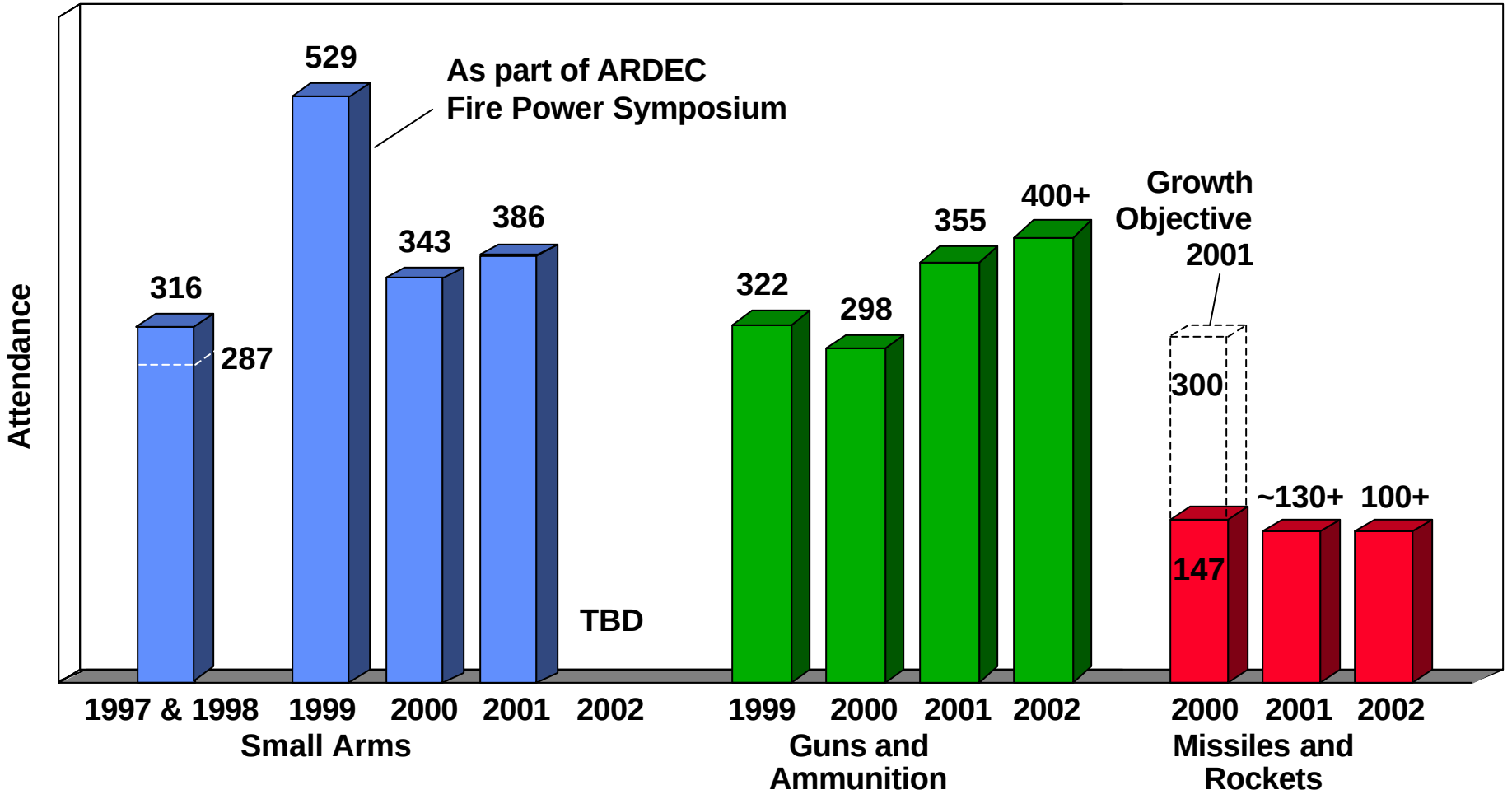
Missiles and Rockets

- Tactical missiles and rockets
- Shoulder fired systems
- Ground launched
- Aircraft/helicopter launched
- System integration
- Life cycle

Common Enabling Technologies, Modeling/Simulation, Man-Tech

Links to Other Committees

Armament Division Attendance Summary



Core Attendance	300	300	Solid Growth Potential

Small Arms Symposium

Forum of Communications

Technology | **Systems** | **Operations**

Lessons Learned

Demonstrations | **Requirements/Definitions** | **Exhibits**

Technology
- Requirements Driven
- Technology Driven

System Development/Application

Producibility

System Engineering – Assessments – Measuring Performance

Readiness – Superior Capability

Small Arms Committee

Activities Supporting Small Arms Community

- Strong symposium programs
- Exhibits supporting readiness and innovation
- Continuing effective use of demonstrations
- Committee of Small Arms Producers (CSAP) leadership
  - Assess issues and approaches to maintain/strengthen small arms readiness . . . industry base . . . DoD activity
  - "Small Arms Center of Excellence"

National Small Arms Center

- Study, plans, and recommendations in process
- Similar to Warheads and Energetic Technology Center (WETC)
- Go-ahead October 2002 if approved — comments welcomed

Small Arms Committee Focus

Maintaining Legacy Readiness

and

Achieving the Objective Force Vision

Future Combat System

Objective Force Warrior

Applying Technology, Integration, Products to Multiple Needs

Synergistic Themes

Small Arms Systems

"21st Century Military Operations and Technology"

Guns and Ammunition

"Innovation for Rapid Deployment and Fielding"

Missiles and Rockets

"Applying Technology for Future Warfare"

Implementing the Themes

Responsive to Transformation

Objective Force

FCS
OFW

Linking Our Resources Achieves the Goal

Small Arms Committee = Supporting the Vision

Legacy Systems

- Readiness
- Product improvement
- Lightweight capability

Objective Family

- OICW
- OCSW
- Development/qualification/FUE

Future Technology/Systems

- Light Fighter Lethality (LFL)
- Technology enhancement
- Netted fires

Objective Force

- Definition
- Development
- Introduction
- Spiral development

Challenge

- Defining small arms systems for Objective Force
- Networked firepower
- Apply advanced situation awareness

Linking – Government and Industry – Achieving Objectives

21st Century Military Operations and Technology

Small Arms Committee Challenges

- Understanding and responding to vision
- Addressing **"Soldier as a System"** including lethal elements
- "Outside the box" approach to systems
- Innovation → operations, integration, technology
- Effective technology insertion with "value added"
- Applying spiral development
- Ruggedness
- Affordability
- Knowledge transition and mentoring

Linking and Integrating with Objective Force
Strengthened by Linking with Other NDIA Elements

Armament Division Focus 2002

Ensuring Capability Readiness Today and in the Future

Innovation | **Responsiveness** | **Openness**

Partnerships **Industry ® Development ® User**

- Responsive to user operational concepts
- Readiness today and future
- Technology assessment and evolution
- Management and engineering processes
- High quality
- Affordability
- Knowledge transition mentoring

Armament Division Strategic Plan 2002 "Challenges"

- Involve the user community effectively
  - Presentations and committee membership
- Focused attention to DoD initiatives to ensure responsiveness/awareness
  - Transformation
  - Objective Force
    - Future Combat System (FCS)
    - Objective Force Warrior (OFW)
- Relevant topics and executing Value Added STUDY with "meaty" recommendations
- Synergistic dialogue with other NDIA divisions/sections
- Linking common benefits sections to chapters

Response to Challenge → Response to DoD Initiatives
→ Ensure Value Added
→ Establish Partnerships

Armament Division Leadership Opportunities

- Open “outside the box” solutions which can be “realized”

  No Luddites!

- User linkage → adapt systems to evolving threats/scenarios and operational needs
- Leveraging synergism
  - Technology
  - System integration
  - Netted systems benefits
- Spiral development benefits
- Answer “What is Armaments Division Role in Homeland Defense?”
- Committee participation and leadership
- NDIA linkage: Divisions — Committees — Chapters

NDIA International Symposium Links

Objective: International cooperation and integration of symposiums benefiting industry and Department of Defense to encourage partnerships for development, production, and interoperability

Approach: Coordination of NDIA Armament Division programs with "Symposium at Shrivenham" The Royal Military College of Science

European Small Arms and Cannon Symposium

27–29 August 2002

Armaments Division Synergism

Small Arms System

- Operational synergism
- Technology commonality
- Convergence in Systems Integration
- Network applications

Guns and Ammunition

Missiles and Rockets

Complimentary Technology, Integration, and Operations

Leveraging Adds Value Throughout Life Cycle

Bottom Line

NDIA Focus

Addressing Issues Critical to Small Arms Committee

Armament Division Focus

- Strong interest and participation
- Linked to key DOD and service strategies
- Effective use of exhibits and firing demonstration
- Transitioning membership and participation profile

Establishing a Vision for 21st Century Partnership

Applying System Synergism to Meet Transformation Goals

NDIA Top Issues for 2002

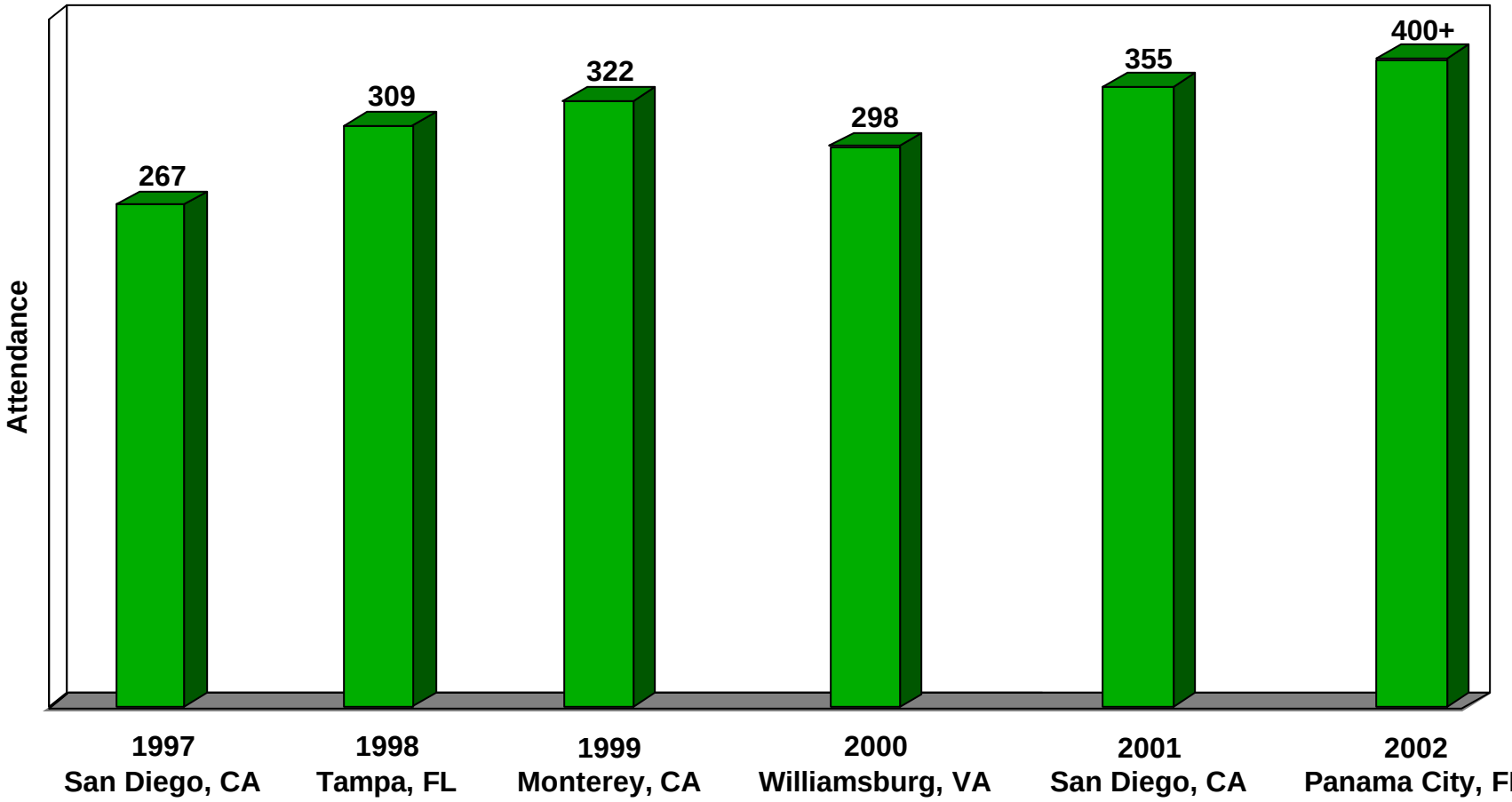
- Funding America's defense
- Protecting the Homeland
- Ensuring the health of the defense industrial base
- Improving training and logistics support
- Reforming international trade processes and cultivating foreign relationships
- Focusing on human capital
- Establishing and maintaining information dominance

Issues are Relevant to Small Arms Committee

Armament Division Section Attendance

Guns and Ammunition

- Stable interest
- Balanced community
- Evolving Section scope to expand participation
- Integrating Munitions Division



2002 International Infantry & Joint Services
Small Arms Systems Section Symposium
Exhibition & Firing Demonstration
21st Century Military Operations and Technology



Program Executive Office Soldier

Soldier Systems Architecture "The Soldier As A System"

Mr. Dan Causey, Jr.
PH- (703) 704-1410 DSN 654
FAX- (703) 704-1110
E-mail: dan.causey@peosoldier.nvl.army.mil

15 May 2002

The Need For PEO Soldier

To Treat The Soldier As A System & Sponsor Soldier-Centric Design

1980's & 90's
Chaos We Started From

- Protective Mask
- Clothing Bag
- BDU
- Weapon Sys
- Ballistic Prot.
- Combat Boot
- Computer
- Sleeping Bag
- Load Carrying
- Radio
- Underlayers
- Gloves
- Night Vision
- Environ. Clothing
- Protective Suit
- Ammo
- Protective Eyewear
- Optics

TEAM SEP/CIE

1999-2000
Initial Steps We Made

- Load
- Armor
- Combat Ammo
- Non-Lethal Ammo
- Displays
- Electronics
- Prot. Mask
- Eye Prot.
- Modular Weapons System
- Load
- Armor
- Sleeping Bag
- Optics



Land Warrior V0.6 To V1.0

2002
We Are Now

NEAR TERM

INTERFACE

- Display
- Elect
- PWR
- Fire Control
- Load
- NV
- Armor
- Weapons Sys



INTEGRATION

FOCUSED EFFORT

DARPA | RDEC | NAT.LABS | INDUSTRY

2008
We Are Going

FAR TERM

FULLY

- ACU
- C~S
- MFL's
- Hybrid Fuel Cell
- Increased Data Rate
- Body Suit w/Sensors
- Integrated Commo
- Platform Connectivity



INTEGRATED

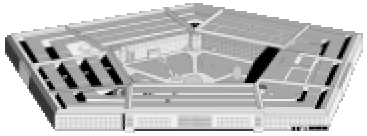
- OICW
- OCSW
- Objective Force Warrior
- Networking

Soldier Systems Architecture

Program Executive Office Soldier

Who We Are, Where We Are, What We Do





- System Coordinator/ System Integrator
- Program Executive Officer Soldier
- DPEO Soldier
  - Business Management
  - Systems Engineering
- Dir Science & Technology
- Project Manager Soldier Systems
  - APM Soldier Power
  - APM Soldier Future
  - APM Soldier Integration
  - DPM Soldier Systems
    - Business Mgt Division
    - Systems Engineering Division
    - Readiness Mgt Division
  - PM Soldier Electronics
  - PM Soldier Equipment
  - PM Aircrew Integrated Systems
  - PM Soldier Sensors
- Project Manager Soldier Weapons
  - APM OCSW
  - APM Integration
  - DPM Soldier Weapons
    - Business Mgt Division
    - Systems Engineering Division
  - PM Small Arms
  - PM OICW

Soldier Systems Integration Focus



PM-Soldier Weapons

- M4 5.56mm Carbine
- M16A4 5.56mm Rifle
- M249 5.56mm Squad Automatic Weapon
- M240B 7.62mm Machine Gun
- MK 19 Grenade Machine Gun
- M1012/M1013 12 Gauge Non-Lethal Ctgs
- XM107 Cal .50 Long Range Sniper Rifle
- XM100 Rifle Launched Entry Munition
- XM116, Sight, Computerized, SAFCS
- M145 Machine Gun Optic
- M68 Close Combat Optic

PM OICW
Objective Individual Combat Weapon

(FY04)
Objective Crew Served Weapon

PM Soldier Sensors

- Head Worn Night Vision Device
- Soldier Thermal Weapons Sight
- Multi-Function Laser
- Laser Rangefinder
- Laser Aiming Device

PM Soldier Systems

- Interceptor Body Armor
- Modular Lightweight Load Carrying System
- Interim Small Arms Protective Vest
- Multi-Purpose Overboot
- Chem.-Bio Protective Gloves
- Joint LtWt Integrated Suit Technology
- Improved Mechanics Coveralls
- Advance Tactical Parachute System
- Laser Eye Protection
- II Generation Extended Cold-Weather Clothing System
- Compact Patrol Pack
- Compression Sack
- Combat ID
- Mid-Sized Riot Control Dispenser
- Extreme Cold-Weather Boot
- Alternate Hot-Weather Boot
- Improved Rainsuit
- Combat Medic Vest System
- Land Warrior
- Mounted Warrior

STRICOM
- Mission Rehearsal
- Training

CECOM
- Processing Architecture
- Computer Architecture
- Security Architecture
- Comms Architecture

PM-ACIS

- Avn Helmet
- Avn Life Support
- Air Warrior

PEO Chemical/Biological Defense
- Chemical Mask
- Chemical Warning Device
- Chemical Treatment Kit
- Chemical /Biological Warning Devices

PM-Physical Security Equipment
- Hand Held Mine Detector
- Platoon Early Warning System

Soldier Systems Architecture Integrates 346 Programs Internal To PEO Soldier & Countless Others Externally!

Soldier Systems Architectural Approach

The Path From "Standalone" To "System-Of-Systems"

Fully Integrated Soldier Systems:
A "Uniform" That Comes With Computing/Connectivity Built In!
Same Core Functionality In Garrison/Field/Fight Situations!
Common Hardware & Software!
In Peace, Soldiers Are "On Line" Not In Line! In Conflict, All Parts Work Together – From Weapons To Comm's & From Soldier To Vehicle!



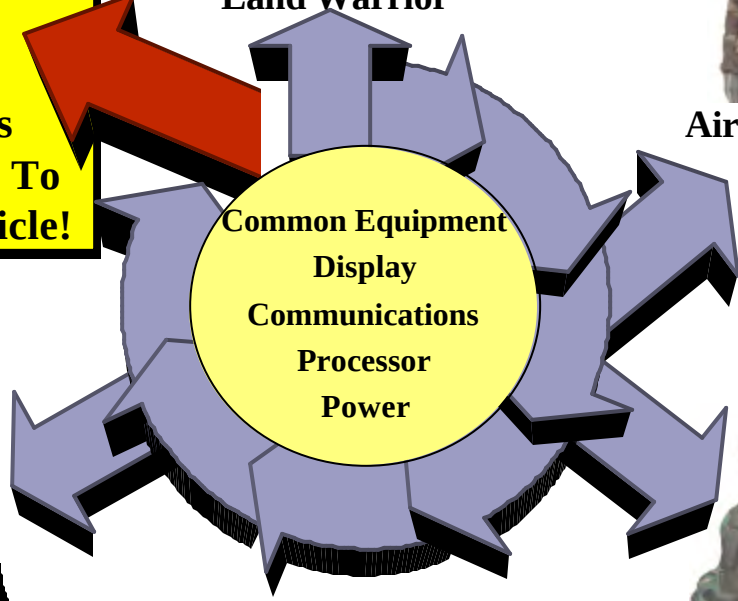
Self & Team Location
SA, Data & Voice Comm's
Helmet Display

Land Warrior



Platform Status
Manage HVAC
Aircraft Comms
Pilot's Associate

Air Warrior



Communications
Computing
At the Desk
On The Run
Business & Tech
"Road Warrior SA"
Specific Job
"Add-In" Capabilities



Connected~Soldier

Connected~Soldiers
Warrior Platforms

Vehicle Status
Weapon Targeting
In/Out Comm's
SA,Voice & Data
Uniform & Armor

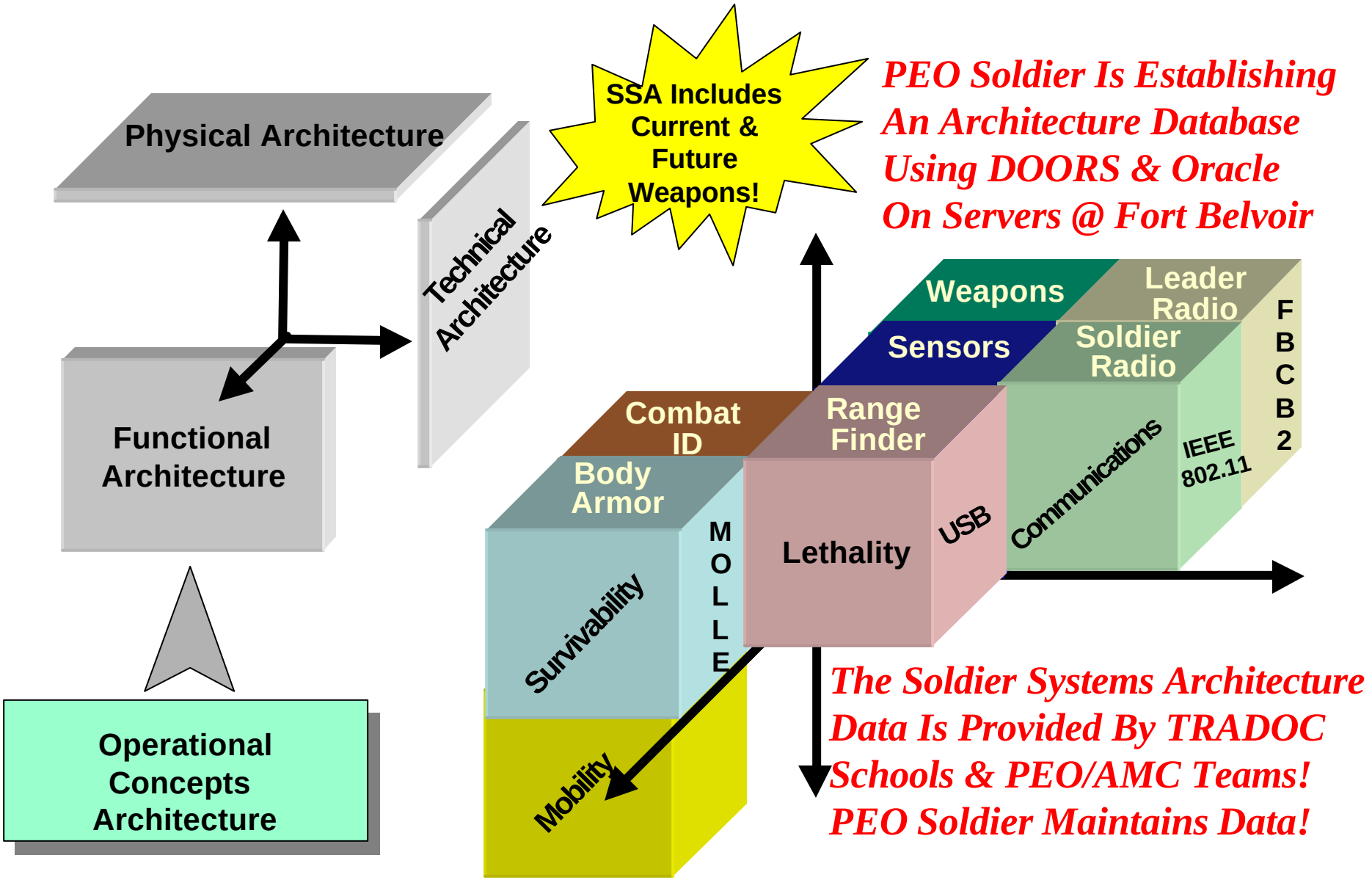


Mounted Warrior

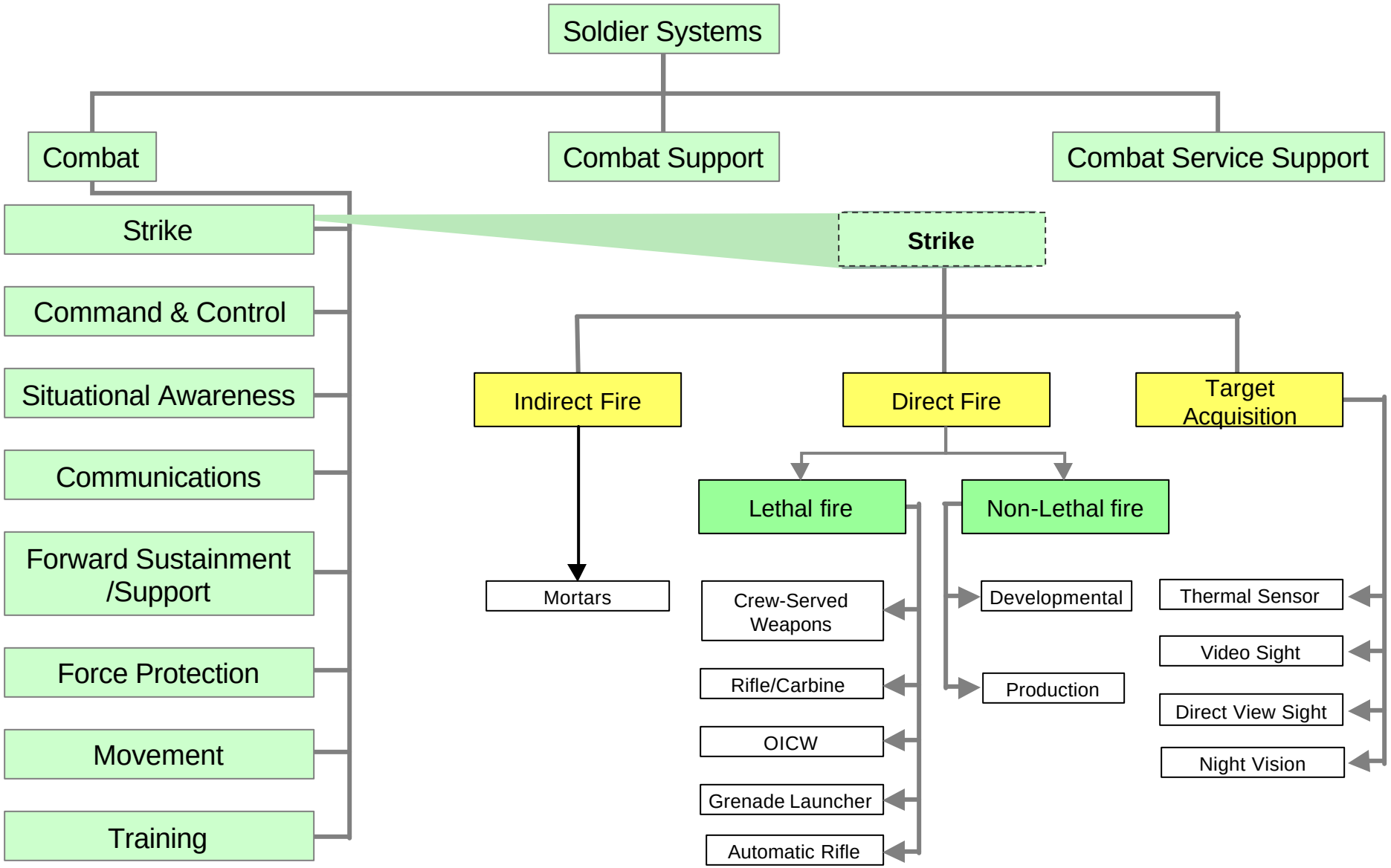
Soldier Systems Architecture = Work, Train, & Fight With Integrated Equipment!

Establishing The Soldier Systems Architecture

Technology Management Tool For Soldier-Centric Design!



Soldier Systems Architecture
Work Breakdown Structure



PRODUCT MANAGER SMALL ARMS

PM SMALL ARMS
Rifles
Pistols
Machine Guns
Grenade Launchers
Ammo
PICATINNY ARSENAL



M16A4



M19 Grenade Machine Gun



NL Bursting Hand Grenade



M84 Stun Grenade



M249 SAW



M4 Modular Weapon System

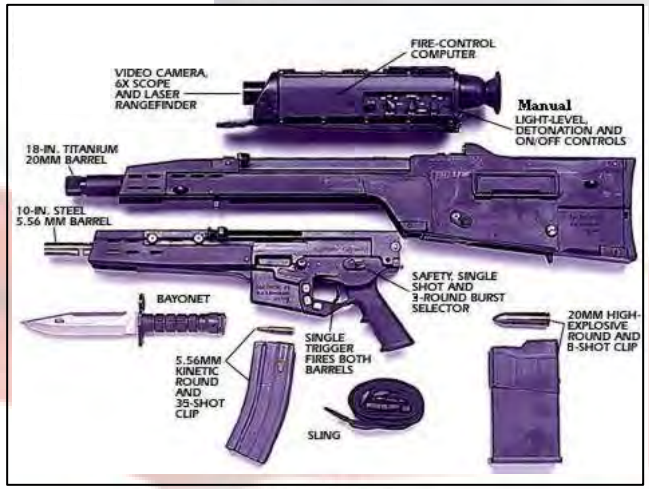
ACAT III

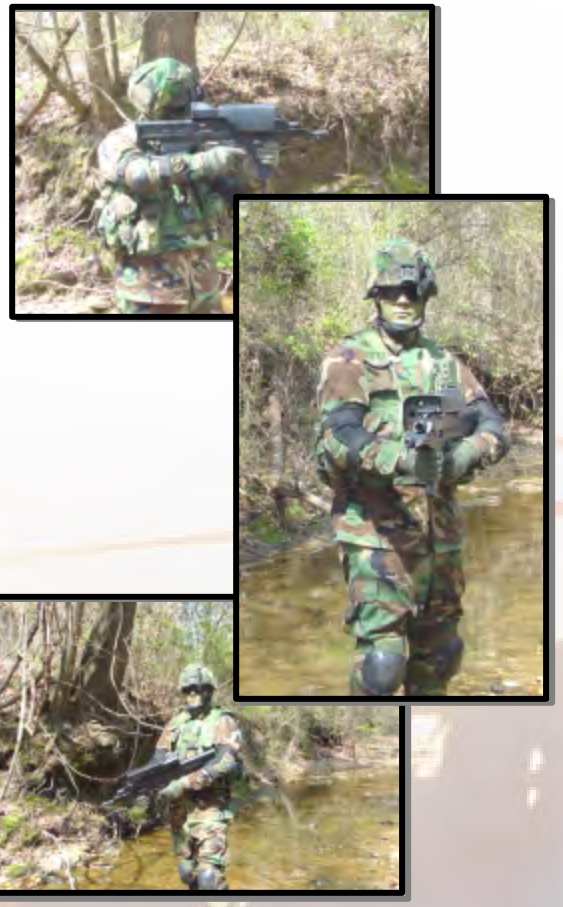
PRODUCT MANAGER OBJECTIVE INDIVIDUAL COMBAT WEAPON (OICW)



Three different 20mm ammunition types for the OICW. From Left to Right: Bursting munition, High Explosive, Target Practice







ACAT II

ASSISTANT PRODUCT MANAGER OBJECTIVE CREW SERVED WEAPON (OCSW)



Program in S&T and will transition to PM Soldier Weapons in FY04

Championing The Soldier As A System
Implementing The Two Teams (ICT & WG)

Described In The Soldier Systems Architecture (Operational, Functional, Physical, Technical)

User Requirements

Lethality
Survivability
Mobility
Sustainability
Reliability
(Specific Schools)

ICT



WG

Developer Products

Land Warrior
Air Warrior
Mounted Warrior
.
Objective Force Warrior
(Specific Platform IPTs)

ICT **WG**

Step One:
Build The Soldier System Architecture (Operational, Functional, Physical, And Technical) & Update As Required Via ICT & WG

Step Two:
Institute The Repetitive User And Developer, Integrated Processes For Using The Architecture – User ICT & Developer Working Group!

The Soldier Systems Architecture
With
System-Level Configuration Management
Allows
Acceptable System Performance @ Reduced Cost & Schedule!

Objective Force System of Systems Soldier-Centric Architecture

Objective Force System of Systems Based On A Soldier-Centric Architecture

Future Combat System (FCS)
Objective Force Warrior (OFW)
FCSS
Integration Of Hardware Software Soldiers

Hardware Software Legacy Systems Architecture

Individual And Collective Soldier Systems Integration

The Connected Soldier Full-Time Situation Awareness

Soldiers With Personal Equipment

The Operational-Functional Reference Model For The Objective Force Architecture Integrates Vehicle And Soldier Sub-Systems Into A Coherent, Synergistic System-of Systems

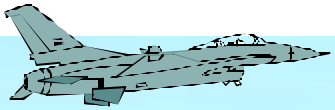


The Overarching Objective Force Soldier-Centric Architecture Is Required To Support An Army Transformation Based On The Legacy Force Recapitalization, The Interim Force Assimilation, And The Objective Force Implementation Of Technologies As They Become Available. Only Thus Will The Objective Force Be The Stated Achievement Of The Army's Transformation Objective Based On A Soldier-Centric Architecture Capitalizing On Technology For Lethality, Speed, And Agility To Serve As A Deterrent To All Potential Adversaries By Supporting A Wide Range Of Flexible National Command Authority Options.



TACOM

Lethality, Survivability, Mobility and Sustainment for America's Army



Tank-automotive & Armaments COMmand

TACOM Welcome

Jerry L. Chapin
Deputy to the Commander

Committed to Excellence

TACOM / (PEO)^4 Partnership

World-wide Collaboration Supporting the Warfighter



An Integrated, Collaborative Approach to Army Transformation

May 2002

TACOM Vision Statement

Linking the Strategic Direction

ARMY VISION

- Soldiers on Point for the Nation: Persuasive in Peace, Invincible in War

  Responsive, Deployable, Agile, Versatile, Lethal, Survivable, Sustainable

AMC VISION

- Dedicated and innovative people paving the way in Army Transformation. We will provide the integrated, cutting edge technology and sustainment needed to create a more responsive, agile, strategically deployable and sustainable Army. While unfailingly meeting our worldwide commitments today, our efforts will help posture the nation to meet the broader demands of the newly emerging missions of the 21st century.

TACOM VISION

- Providing our soldiers with overwhelming lethality, survivability, mobility, and sustainment for battlefield dominance.

Supporting Army Readiness






SUPPORT

Capital Value of TACOM Equipment $81.7B

2993 Fielded End Item NSNs Supported

> 27,000 Component NSNs

PRODUCT LINES

- Combat Vehicles
- Trailers
- Materiel Handling Equipment
- Fuel & Water Dist Equipment
- Chemical Defense Equipment
- Howitzers
- Mortars
- Machine Guns
- Aircraft Armaments
- Rail
- Fuel & Lubricant Products
- Tactical Vehicles
- Construction Equipment
- Tactical Bridges
- Sets, Kits & Outfits
- Shop Equipment
- Large Caliber Guns
- Rifles
- Ammunition
- Demolitions & Explosives
- Watercraft
- Non-Tactical Vehicles

Plus Technology Development for the Objective Force

MAGNITUDE

71% of Army's Reportable Density is TACOM Supported

81 Allied Countries own TACOM Equipment

97% of All Army Parent UICs Contain TACOM Supported Equip





The Army's Lead Systems Integrator

GOAL #1 - A Revitalized Workforce

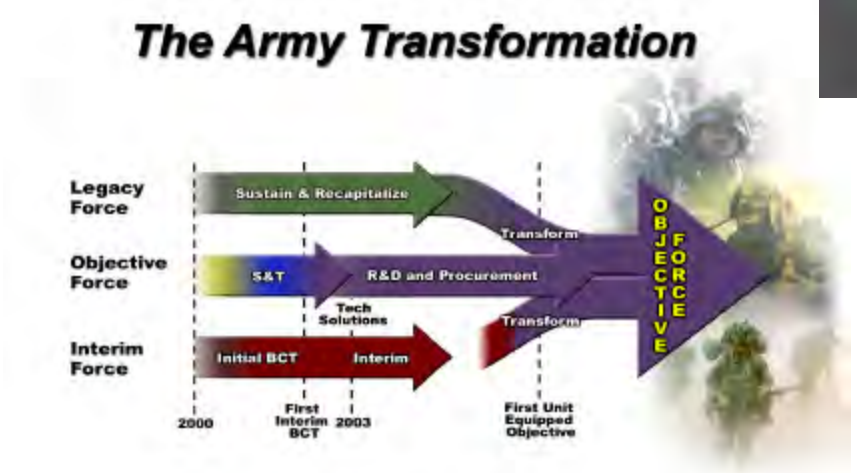
Leadership, Communication, Organizational Climate, Teaming, Strategic Thinking, and Employee Support



Instilling **Desired Leadership Traits**



Idea **Generators**

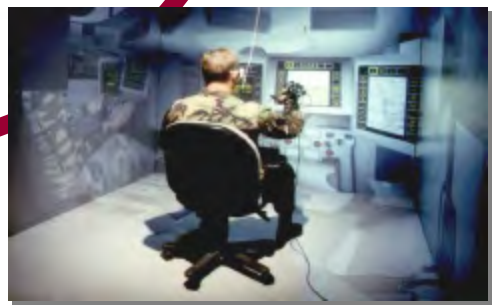


. . . Responsive, Deployable, Agile, Versatile, Lethal, Survivable, Sustainable.

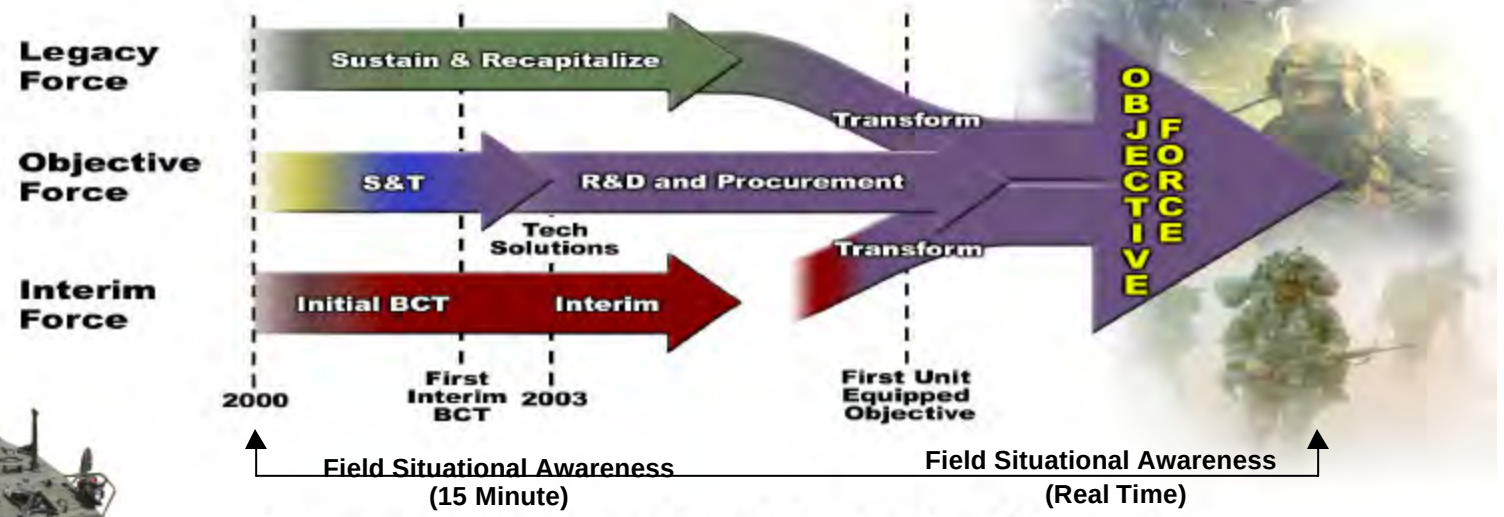
Idea **Integrators**



Building **Organizational Cohesiveness** through a Strong Coalition of Leaders



The Army Transformation





. . . Responsive, Deployable, Agile, Versatile, Lethal, Survivable, Sustainable.

INTERIM BRIGADE COMBAT TEAM

TACOM / PEO Team
Off-the-Shelf Equipment
Surrogate Vehicles
Innovative Acquisition Approaches
Fielding/NET
Capstone Exercise Support
Subsequent Fieldings

INTERIM CAPABILITY

New Technology Insertion
Recapitalize Legend Systems
Equipment Redistribution
Depot Operations
Force Projection Enablers

OBJECTIVE FORCE

Technology Breakthroughs
Future Combat System
Anticipatory & Deployable Logistics

May 2002

The Requirement to Transform



- Security Challenges of the 21st Century
- Pace and Proliferation of Technology
- Compelling Need to Respond More Rapidly & Decisively Across the Full Spectrum of Military Operations

The Army has a Nonnegotiable Contract with the American People to Fight & Win our Nation's Wars

The Objective Force

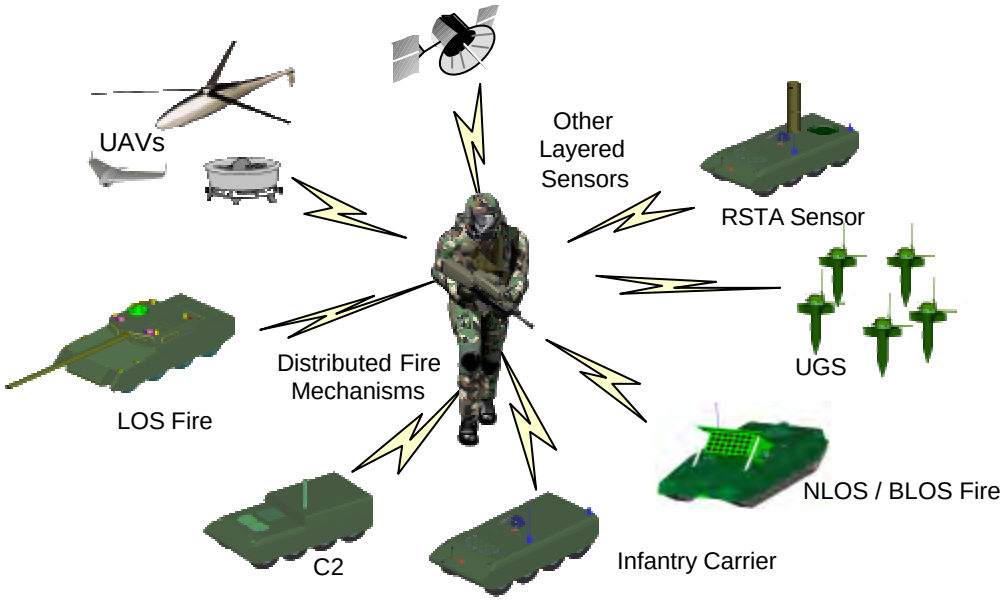


- **Full Spectrum** – general purpose forces with special purpose capabilities, dominant at every point on the spectrum as a member of the Joint Forces
- **Characteristics** – responsive, deployable, agile, versatile, lethal, survivable, sustainable
- **DTLOMS-I³** – synergistic advances in doctrine, training, leader development, organization, materiel, Soldiers & installations
- **Enablers** – self-aware and adaptive Soldiers and leaders, network centric force, and advanced technology
- **Soldiers**– center piece of our formations

The XXIst Century Army

Future Combat Systems (FCS)

FCS *is the* ***networked system of systems*** *that will serve as the* ***core building block within all maneuver Unit of Action echelons*** *to develop* ***overmatching combat power, sustainability, agility, and versatility*** *necessary for* ***full spectrum*** *military operations.*

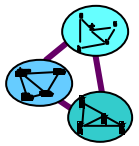


The "Big Five" Plus… in One Unit

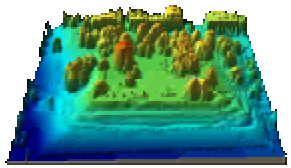
FCS Technologies in Development

C4ISR

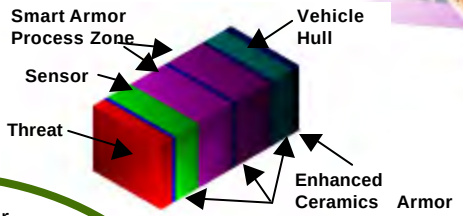
- *Organic 3D Targeting*
- *Mobile C3*
- *FCS Comms - Multi-node high/low band*
- *Tags*
- *All weather OAV sensor – JIGSAW*







Survivability



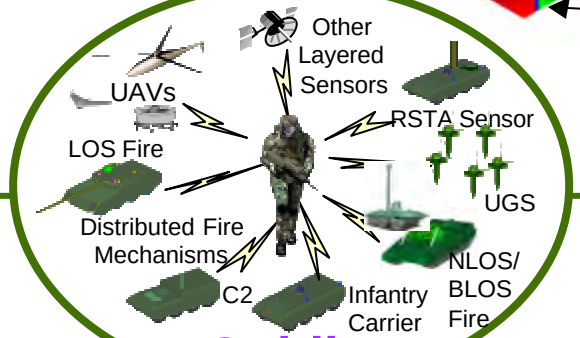
Integrated Armor



Active Protection



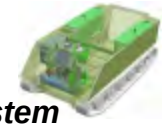
Signature Management



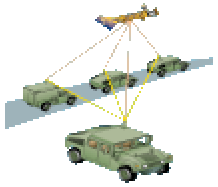
Soldier

Mobility

- *Combat Hybrid Power System*
- *Advanced Diesel*







Lethality







Networked Fires



Compact Kinetic Energy Missile

Human Engineering

Crew Integration & Automation Testbed







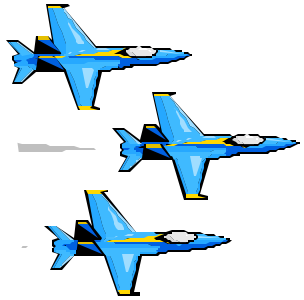
Follower UGV

UAVs



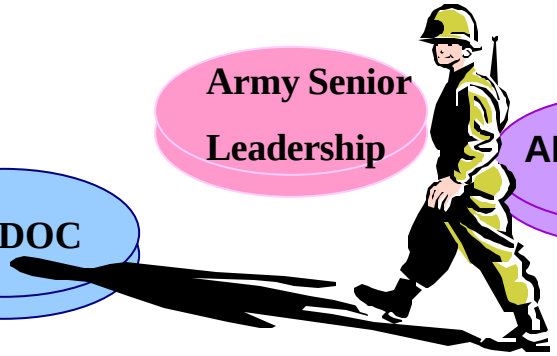
Robotics

Objective Force Partnership

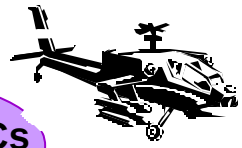




Army Senior Leadership



AMC - MSCs

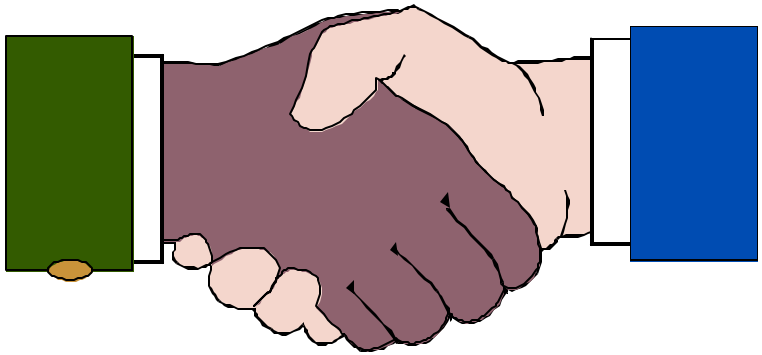


TRADOC

Other Services



ASAALT - PEO - PM



Warfighters



DARPA

OF TF

LSI - Industry



Academia



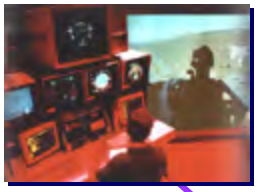
Foreign Governments



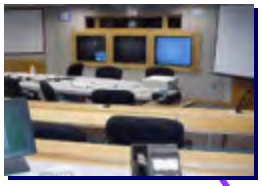
Boeing/SAIC FCS LSI Team

Program Manager (PM)
Jerry McElwee (Boeing)
Washington, D.C.

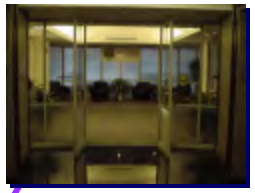
Deputy PM
John Gully (SAIC)
Washington, D.C.



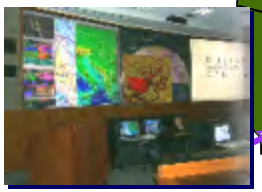
Boeing
Seattle, WA
Program Administration
Systems Engineering
& Integration



SAIC
Philadelphia, PA
Supportability



Boeing
Arlington, VA
PROGRAM MANAGER
Systems Engineering
& Integration
Combat Systems



Boeing
Anaheim, CA
C4ISR Integrated
Simulation & Test

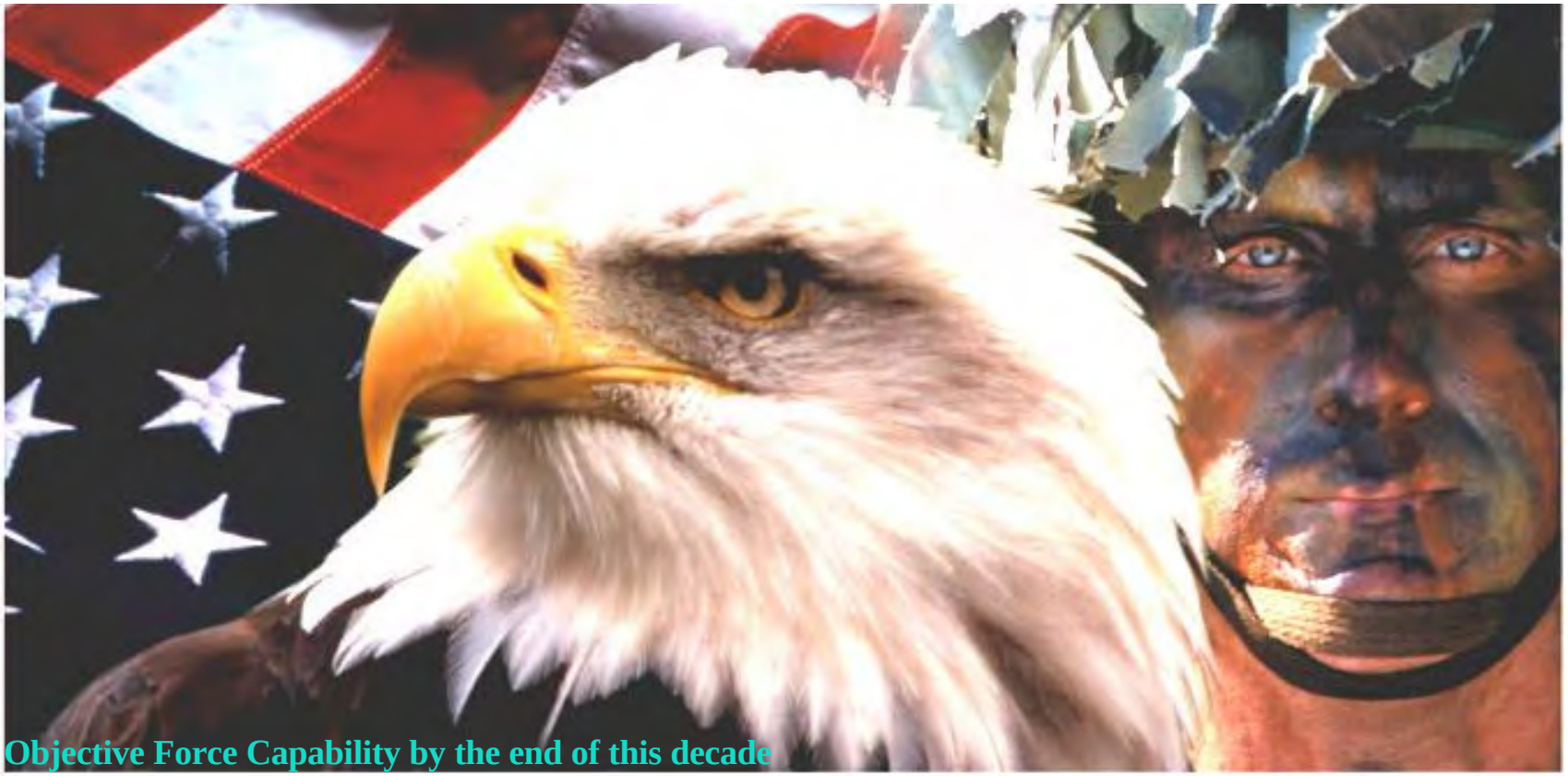


SAIC
Orlando, FL
Training Systems

Key Deliverables

- **System of System Architecture** supports interoperability with legacy and Joint systems
- **Advanced Collaborative Environment**
  - early user involvement in design
  - supports SBA
  - supports Test and Evaluation
- **C4ISR Open Architecture** allows upgrades as technologies mature
- **Demonstrations during CTD** addresses key risk areas
- **Management Plan**
  - supports competitive environment throughout life cycle
  - affords immediate start upon award

The U.S. Army
Tank-automotive and Armaments Command



Committed To Excellence... Routinely

May 2002

National Defense Industrial Association
Small Arms Symposium

Sensors for Small Arms Munitions

MAY 2002

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Ed Moody
RAND
1700 Main Street
Santa Monica, CA 90407

CECOM Bottom Line: THE WARFIGHTER

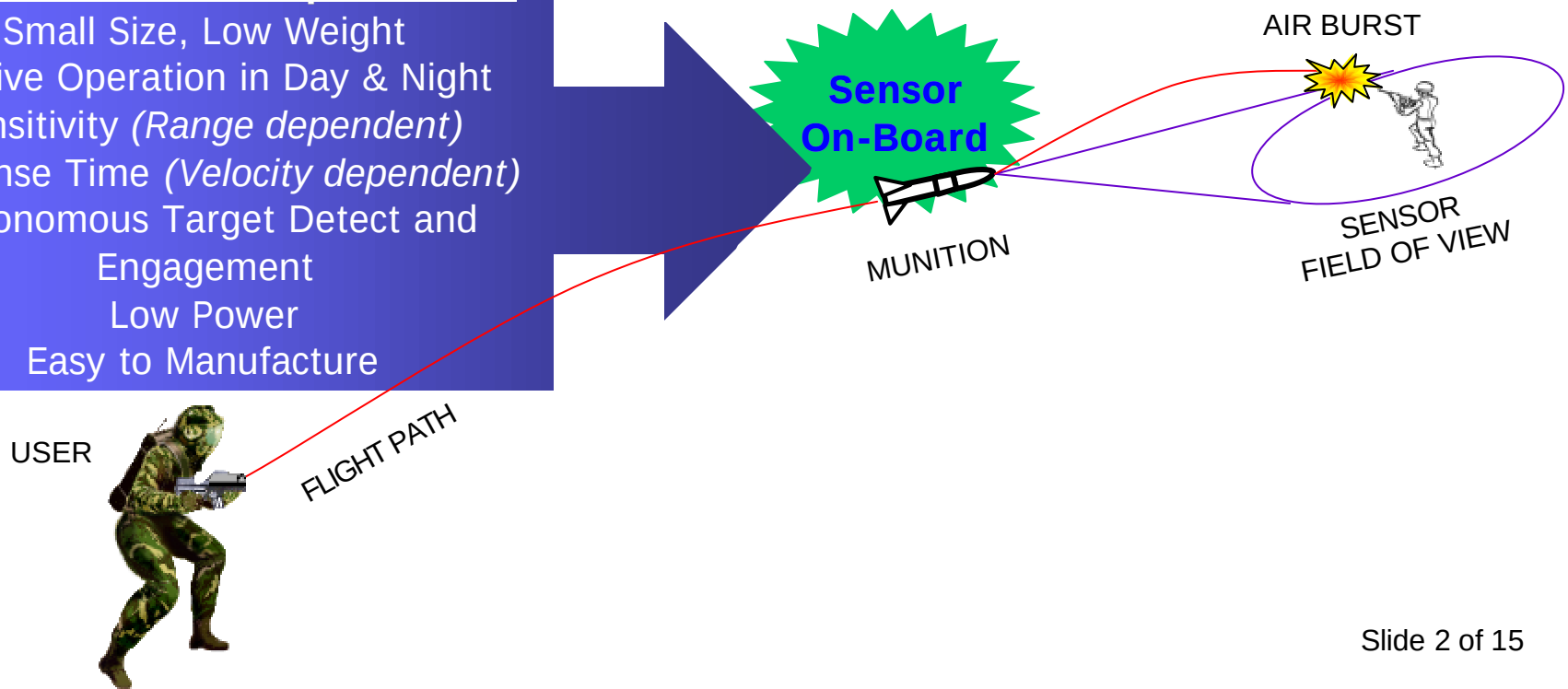
Sensor Integration for Small Arms Smart Munitions

What advantages can a Small Arms Smart Munition offer to the 21st Century Soldier?

- **Increased Lethality (High Probability of Incapacitation, P(I))**
- **Simplicity in Operation (Locate Target, Point, Fire and Forget, not laser designated)**
- **Effective For Multiple Enemy Positions (Moving, Stationary, in Defilade)**
- **Lightweight Weapon System (Soft-launched autonomous munition)**

Projectile Sensor Requirements

Small Size, Low Weight
Passive Operation in Day & Night
Sensitivity *(Range dependent)*
Response Time *(Velocity dependent)*
Autonomous Target Detect and Engagement
Low Power
Easy to Manufacture



Concept of Operation For Small Arms Smart Munition

Sequence of Events on the Fire Control System (individual weapon)

- Detect target and Acquire target location information.
- Compute flight trajectory, target image(s), Download to munition.
- Elevate weapon, Soft-launch munition.

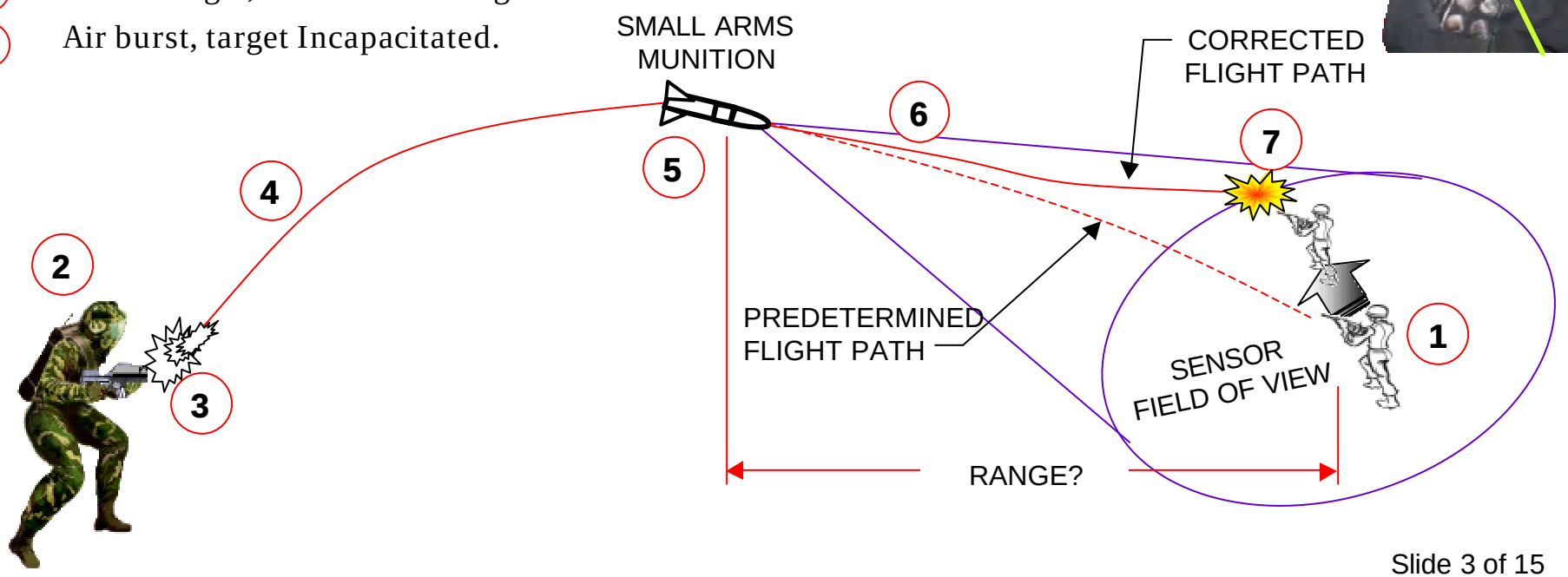
Sequence of Events on the Small Arms Munition

- Follow predetermined flight path to known target location.
- Activate sensor and Look for target.
- Detect target, Maneuver to target.
- Air burst, target Incapacitated.

21st Century Visionary Soldier

- Individual Weapon
- Electronic Compass
- Laser Rangefinder
- Infrared Sensor



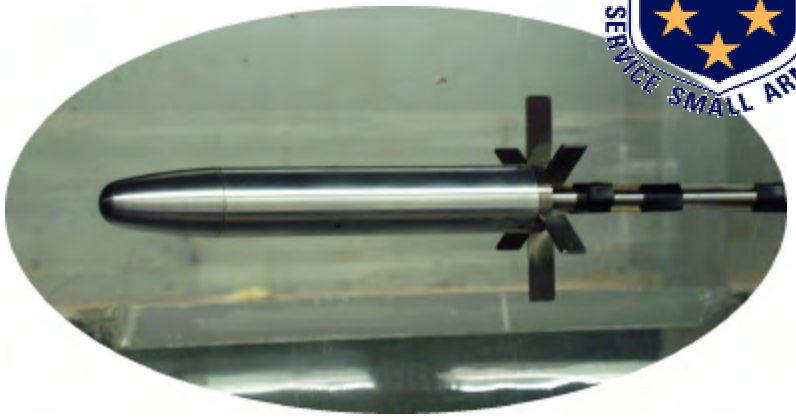


Light Fighter Lethality (LFL)
Small Arms Smart Projectile Example

Need Munition Characteristics to Focus Sensor Development/Specifications

Propose the Light Fighter Lethality (LFL) Seeker Projectile being developed by JSSAP

- Fin Stabilized – Maximum Spin Rate: 6 Hz
- Diameter: 25.0 mm
- Length: 165 mm (6.1”) unfolded
- Weight Goal: 0.5 lbs
- Maximum Flight Velocity: 160 m/s
- Maximum Engagement Range: 500 m
- Time of Flight: 4 s
- Target Type: Personnel in Body Armor



Based on above, Propose Using a 8-12 micron Uncooled Staring Microbolometer Sensor

Advantages:

+ Small Size (no scanning)
+ Low Weight, Low Power (with no TE cooler)
+ Passive, All Weather Operation
+ Medium to High Sensitivity
+ Manufacturing Processes Improving

Disadvantages

- Not Spin Insensitive (current pixel design)
- Non-Uniformity Correction (Calibration)
- Sensor Noise
- Thermoelectric (TE) Cooling currently

Sensor Development Outline

GOAL: Detect a personnel target with high probability early in projectile flight to provide adequate range and time for maneuvering.

FIRST: Determine the suitable Field of View (FOV) for the optics to fully contain the target based on projectile flight path. Concurrently, design external profile to satisfy aerodynamic stability. (slide 6&7)

SECOND: Optimize sensor array size for the given FOV and determine appropriate focal length to satisfy projectile physical constraints. (slide 8)

THIRD: Determine thermal time constant to minimize image degradation induced by projectile spin rate. (slide 11)

FOURTH: Determine detector sensitivity required to resolve target at sensor turn-on range. (slide 12)

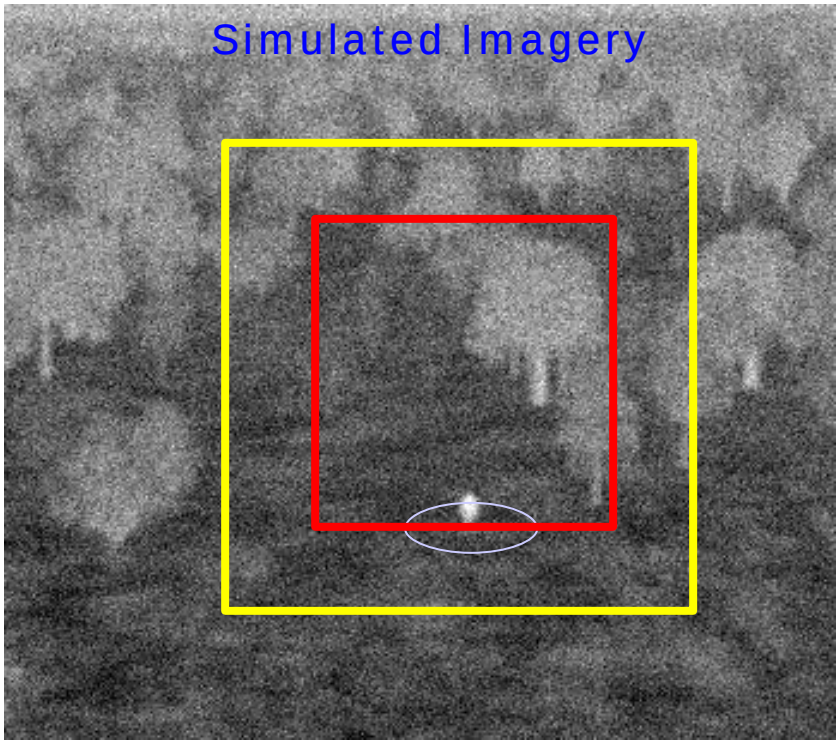
FIFTH: Predict detector sensitivity and thermal time constant values necessary to achieve a 70% probability of detection for a personnel target to satisfy the LFL application. (NVTherm Model) (slide 13)

SIXTH: Identify any issues associated with the sensor development results. (slide 14)

Field Of View (FOV) Analysis at Sensor Turn-On

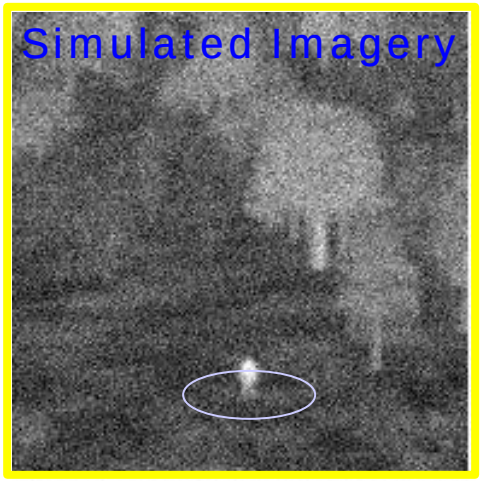
(Range: 265m, Altitude: 16.8m, -0.11°, TOF: 2.2sec)

Range to Target is 235 m



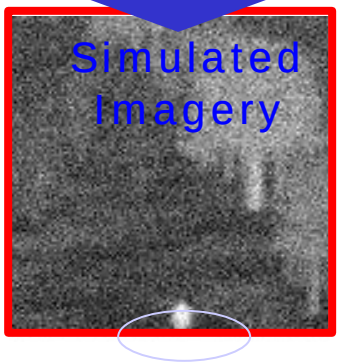
~10º Field of View

Circle is how far target could have run in the elapsed time from initial target acquisition to sensor turn-on.



8º Field of View

Requires Decreasing Projectile Altitude Or Later Turn-On!



6º Field of View

Field of View Must Encompass

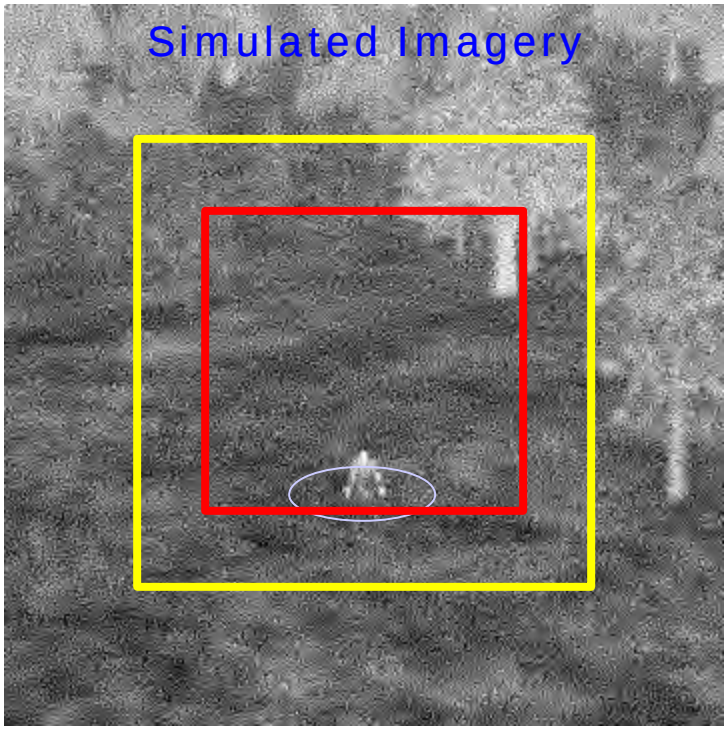
- Target upon turn-on without affecting projectile flight.
- Distance the target can run in available time.
- Errors associated with the targeting devices (such as the laser rangefinder, digital compass).
- Errors associated with projectile flight trajectory.

10° Is Excessive, 6° Is Too Small in Azimuth, 8° Is Sufficient.

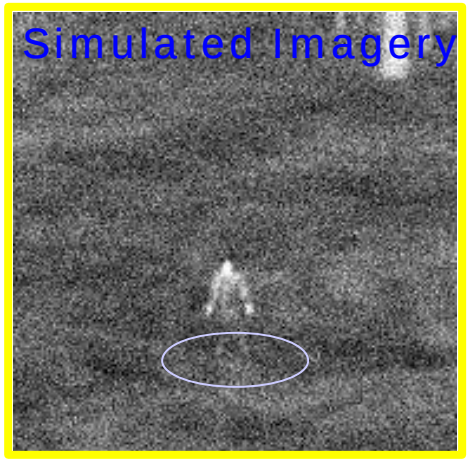
Field Of View (FOV) Analysis at Closer Range to Target

(Range: 413m, Altitude: 10.8m, -4.7°, TOF: 3.3sec)

Distance to Target is 87 m
Time to Impact is 0.7 sec



~10º Field of View



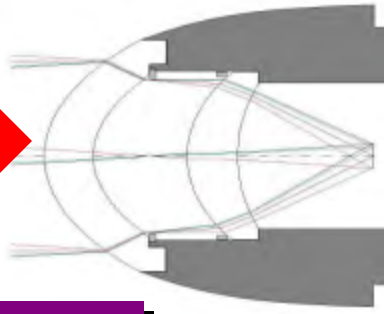
8º Field of View



6º Field of View

Circle indicates how far the target can run before the projectile reaches the target.

External Profile Satisfies Aerodynamic Stability Factors



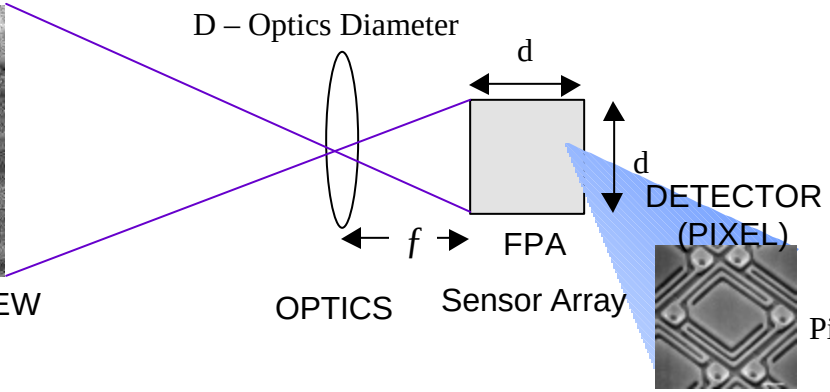
Shorter Range to Target Reduces Amount of Scene Coverage

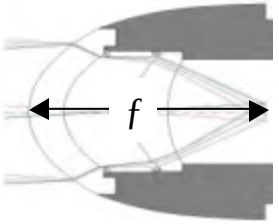
In Addition to Time Available for Projectile Course Correction

Focal Plane Array (FPA) Optimization Analysis



8° X 8° FIELD OF VIEW





Pixel Pitch -detector width

$$FOV = 2\tan^{-1}\left(\frac{d}{2f}\right)$$

$$IFOV = \left(\frac{FOV}{\#Pixels}\right)$$

$$F\# = \left(\frac{f}{D}\right)$$

Determine Appropriate Focal Plane Array Size to Best Resolve the Required Field of View.

Dependent On:

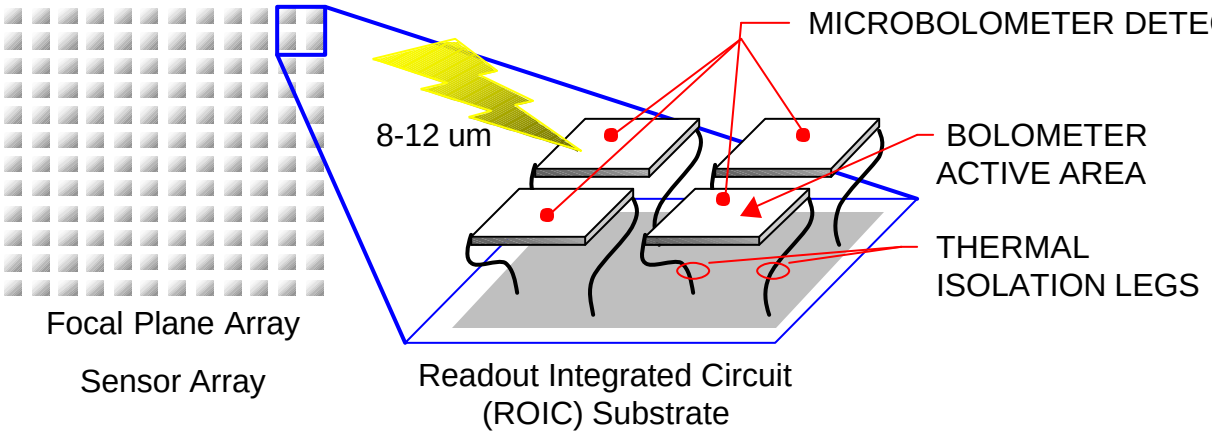
•	Number of Detectors	Many	Higher Resolution, Small IFOV
		Few	Lower Resolution, Large IFOV
•	Pixel Pitch	Large	Large FPA Size, Long Focal Length (f)
		Small	Small FPA Size, Short Focal Length (f)
•	Processing Consideration	Many Pixels	More Image Processing per pixel
		Few Pixels	Less Image Processing per pixel

PERFORMANCE TRADEOFF

Desire The Most Compact Optical System That Sufficiently Resolves The Target.

Result: 64 x 64 FPA, 25 µm pixel pitch, 11.5 mm (0.45”) focal length, 0.13° IFOV, 0.9 F#.

Microbolometer Detector Operation and Characteristics



Microbolometer Detector Operation

- Active Area absorbs incoming Infrared (IR) energy.
- IR energy produces a change in detector resistance across legs.
- Resistance change is sensed by integrating bias current or voltage.
- Resulting detector signal is read out and digitized.

The larger the change in resistance, the more IR energy was absorbed, and the thus the "hotter" the target.

Sensitivity
Determines the smallest temperature difference.

How far can you see?

Thermal Time Constant
Determines detector speed of response by the following equation:

$$t_{th} = C / G$$

where C = Thermal Heat Capacity (J/K)

G = Thermal Conductance (W/K)

How fast can you see it?

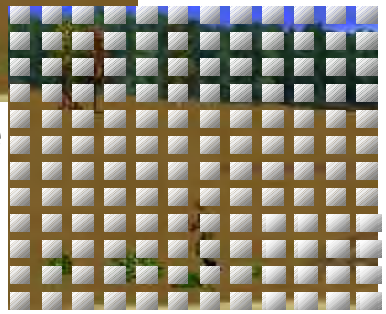
Sensitivity and Thermal Time Constant are Inversely Proportional Based on Material Properties, Thermal Mass and Physical Geometry.

Issue of Projectile Spin on Sensor Effectiveness

NO PROJECTILE SPIN



Visible Scene



Scene Imaged by Static FPA

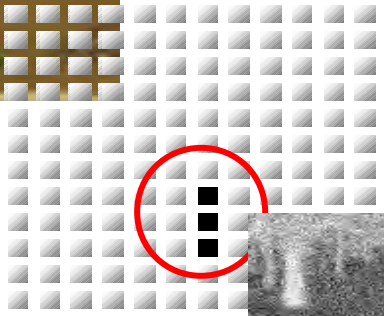
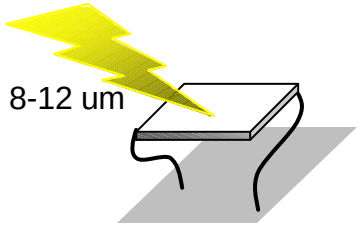


Image Readout



Thermal Image



IR Energy Contained within the IFOV is Absorbed by the bolometer.

PROJECTILE SPIN

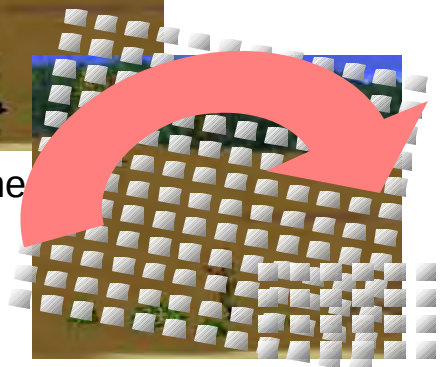
6 Hz Spin = 2160º rotation/second

For single detector with τ_{th} = 10ms,

scene IFOV rotates by **21.6°!!!**



Visible Scene



Scene Imaged by Rotating FPA

Target Contrast Decreased ! Aspect Ratio Changes !

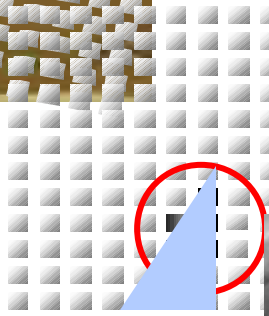
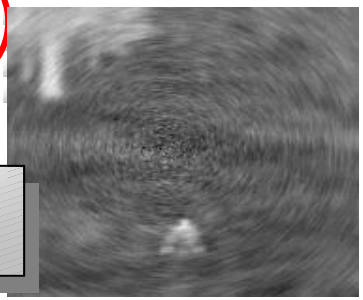


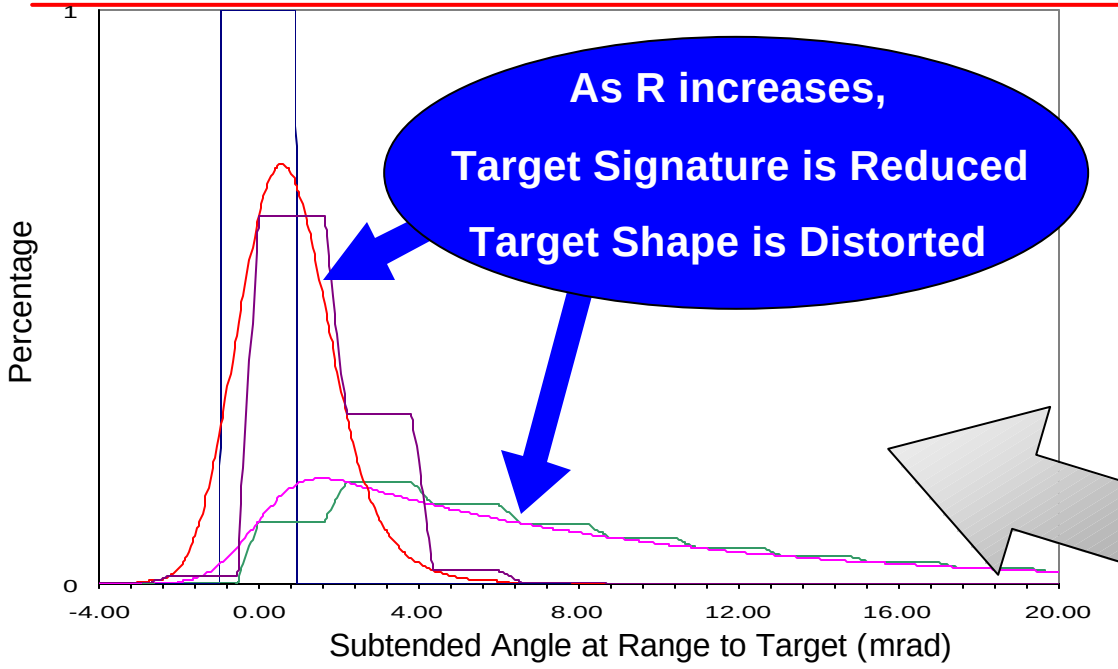
Image Readout

Effect worsens at FOV extremes.



Thermal Image

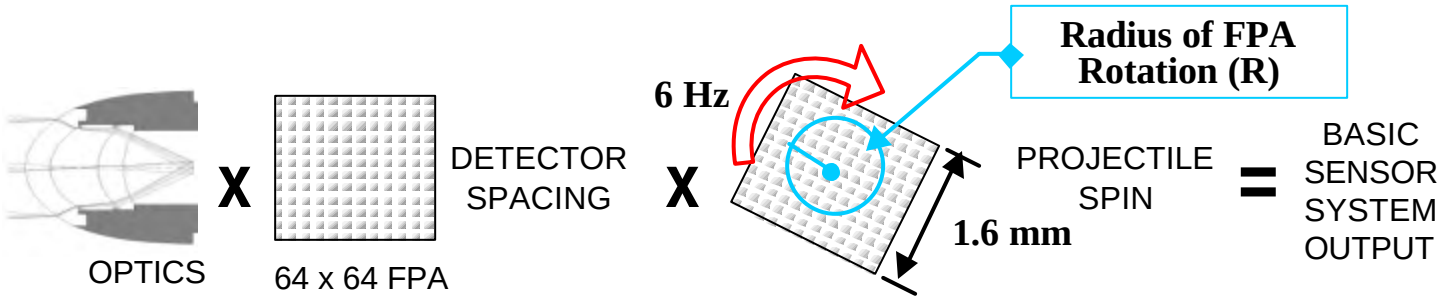
Projectile Spin Analysis (cont'd)

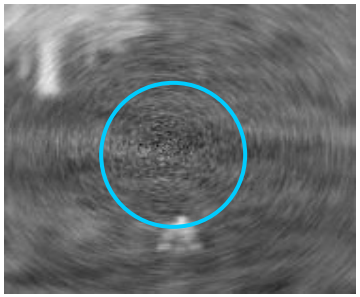


Sensor Parameters:
Field of View: 8° x 8°
Array Size & Pixel Pitch: 64 x 64, 25µm
Thermal Time Constant = 1.5ms
Range of Target = 234m

As Seen Above, Effect Worsens With Larger Radii of FPA Rotation (R).

With Thermal Time Constants (t_{th}) > 1.5ms, The Result is More Dramatic.

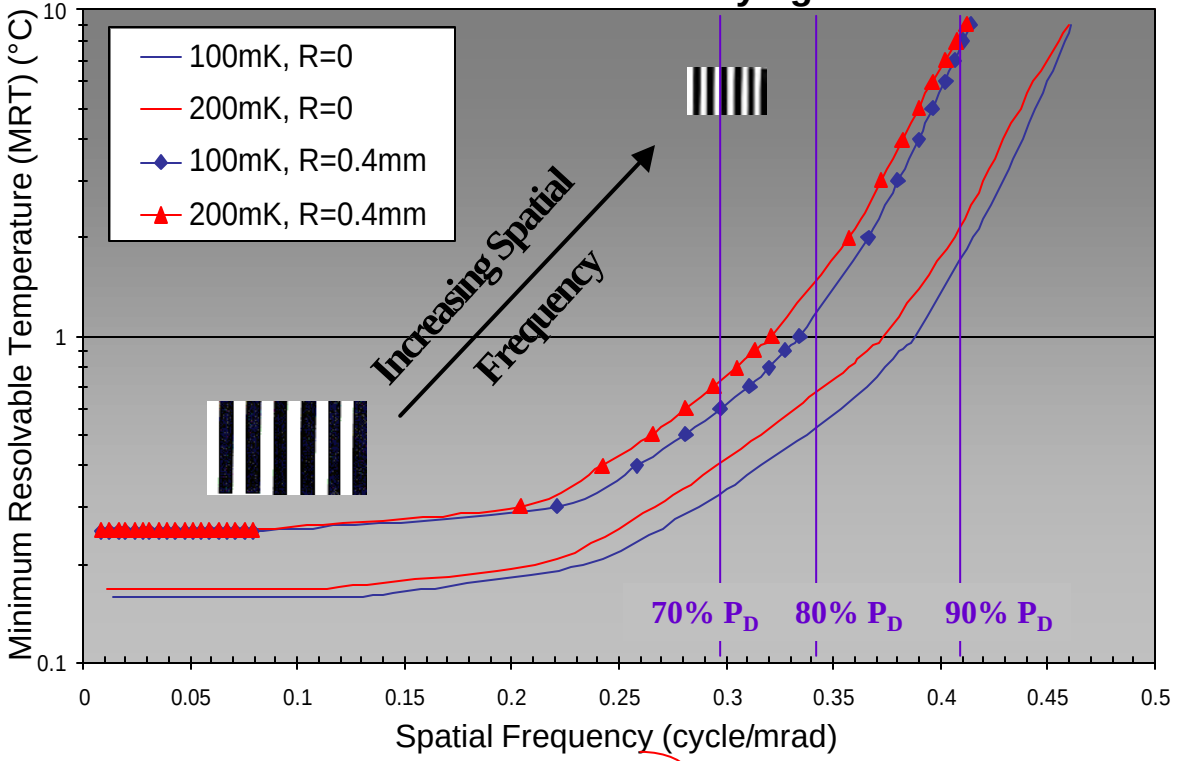




Thermal Image Representation

Required Sensor Performance at Sensor Turn-On Range
(234m to target)

2-D MRT Performance Chart for Varying Detector Sensitivities



MRTD is the minimum temperature difference between a standard target and the background that is required in order for a standard observer to just fully resolve the target. It is the best overall indicator of thermal imager system performance.

- FLIR92 Thermal Imaging Systems Performance Model, NVESD, Fort Belvoir, VA, Jan 1993.

Sensor 2-D MRT

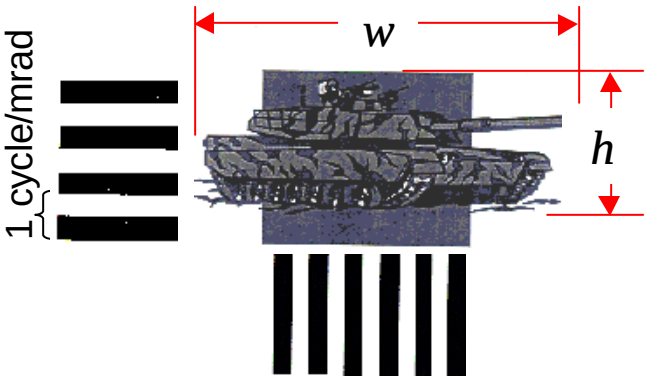
Atmospheric Transmission (0.7km^{-1})

Target-to-Background ?T (1.25° C)

Target Critical Dimension (d_c) (0.75m)

Plug into NVTherm Model, Output is a Range Performance Estimate for Probability of Detection

Johnson Criteria



$d_c = (w * h)^{1/2}$

Verify Sensor Parameters Through Sensor Performance Modeling

Sensor Parameters

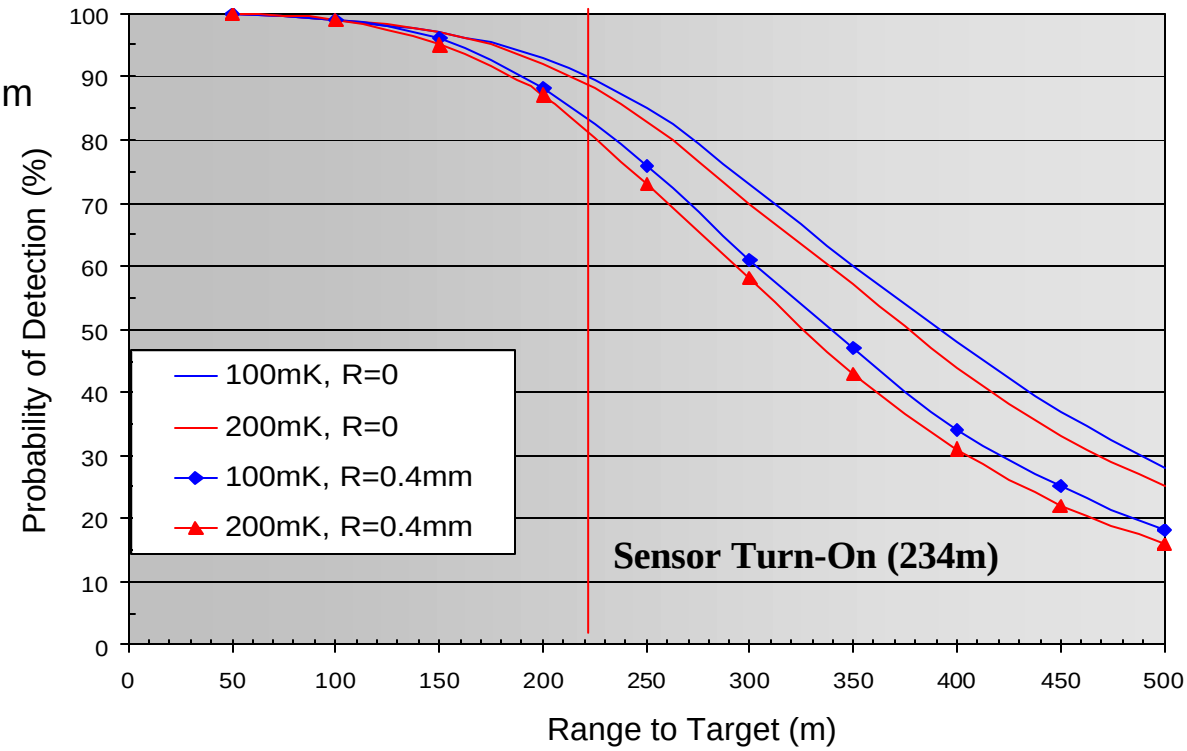
Focal Plane Array Size	64 x 64 pixels
Detector Sensitivity	100-200mK (f/1@30Hz)
Thermal Time Constant	1.5ms (minimum)
Pixel Pitch	25µm
Field of View	8° x 8°
Focal Length	11.5 mm
F#	0.9

NVTherm is a computer model that is used to estimate the performance of thermal imaging systems. It was developed by the CECOM RDEC Night Vision & Electronic Sensors Directorate (NVESD), Fort Belvoir, VA.

Range Performance Estimates

Prob. of Detection	100mK	200mK
70%	270m-312m	260m-300m
80%	217m-233m	225m-262m

Sensor Range Performance from NVTherm



Sensor Development Issues

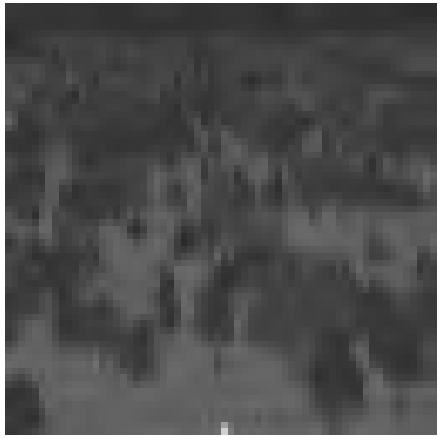
Factors Not Accounted For in Current Sensor Development:	Impact
• Software-in-the-loop operation for personnel target detection.	Moderate to High
• Verify operational timelines can be satisfied through the interaction of the guidance and control unit to the automatic target detection process.	Moderate
• Noise considerations(non-uniformity, fixed pattern noise).	Moderate to Low
• LFL Seeker Projectile flight errors on FOV optimization.	Moderate to Low
• Target aspect ratio based on projectile Angle of Attack (AoA).	Low (<5° AoA)

Factors Associated with NVTherm Range Performance Results	
• Does not account for software-in-the-loop target detection.	Moderate to High
• 70% Probability of Detection is conservative estimate for **man-in-the-loop.**	Moderate

Software-in-the-Loop Design Integration Will Be Addressed In Future Analysis. However, The Analysis To Date Still Proves That Sensor Parameters Can Be Adjusted To Satisfy The LFL Seeker Projectile Application.

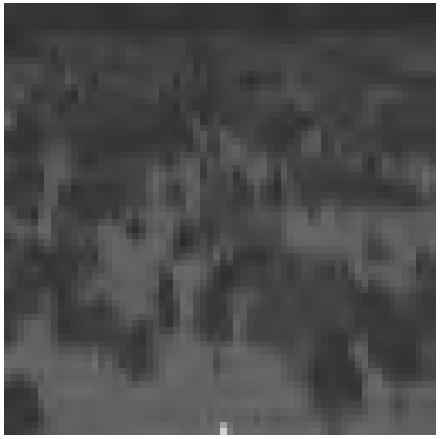
Summary and Future Work

- Investigate Prototype Development of an Uncooled, Small Array Sensor for Use in Smart Munitions.
  - Revise Sensor Parameters To Consider Munition Guidance and Control Capabilities.
  - Uncooled Detector Technologies Have Improved In Recent Years (assuming reasonable temporal response and sensitivity requirements).
  - Electronics Required to Readout the Sensor Images Can Be Produced.
- Investigate Issues Associated with the Software-in-the-Loop issue for Automatic Target Detection.
- Continue Development of the LFL Seeker Projectile Sensor Simulation as a Sensor Analysis Tool.



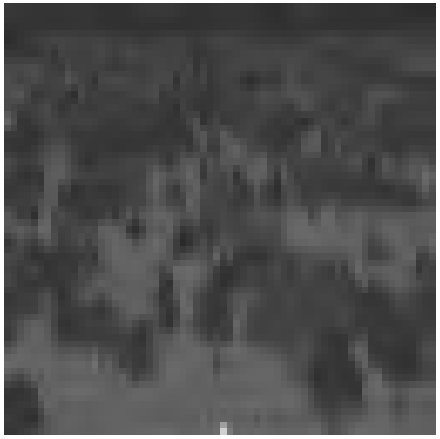
LFL Simulation

Real-Time Speed



LFL Simulation

1/3 Speed



LFL Simulation

1/10 Speed

TACOM

Lethality, Survivability, Mobility and Sustainment for America's Army

Army-Led, Joint Non-Lethal Weapons

Crowd Control & Area Denial to Vehicles Concept Exploration Programs

2002 International Infantry & Small Arms Symposium, Exhibition & Firing Demonstration

21st Century Military Operations and Technology

14 May 2002

Atlantic City , NJ

John Cline
AMSTA-AR-CCL-D
U.S. Army TACOM-ARDEC
Com (973) 724-7317

Tank-automotive & Armaments COMmand
Committed to Excellence

OUTLINE

- DoD NLW Policy
- Organizations and Roles
- Joint Mission Area Analysis
- Concept Exploration Programs
  - Crowd Control
  - Area Denial to Vehicles
- CEP Process & Challenges
- Conclusion

Why Non-Lethal?

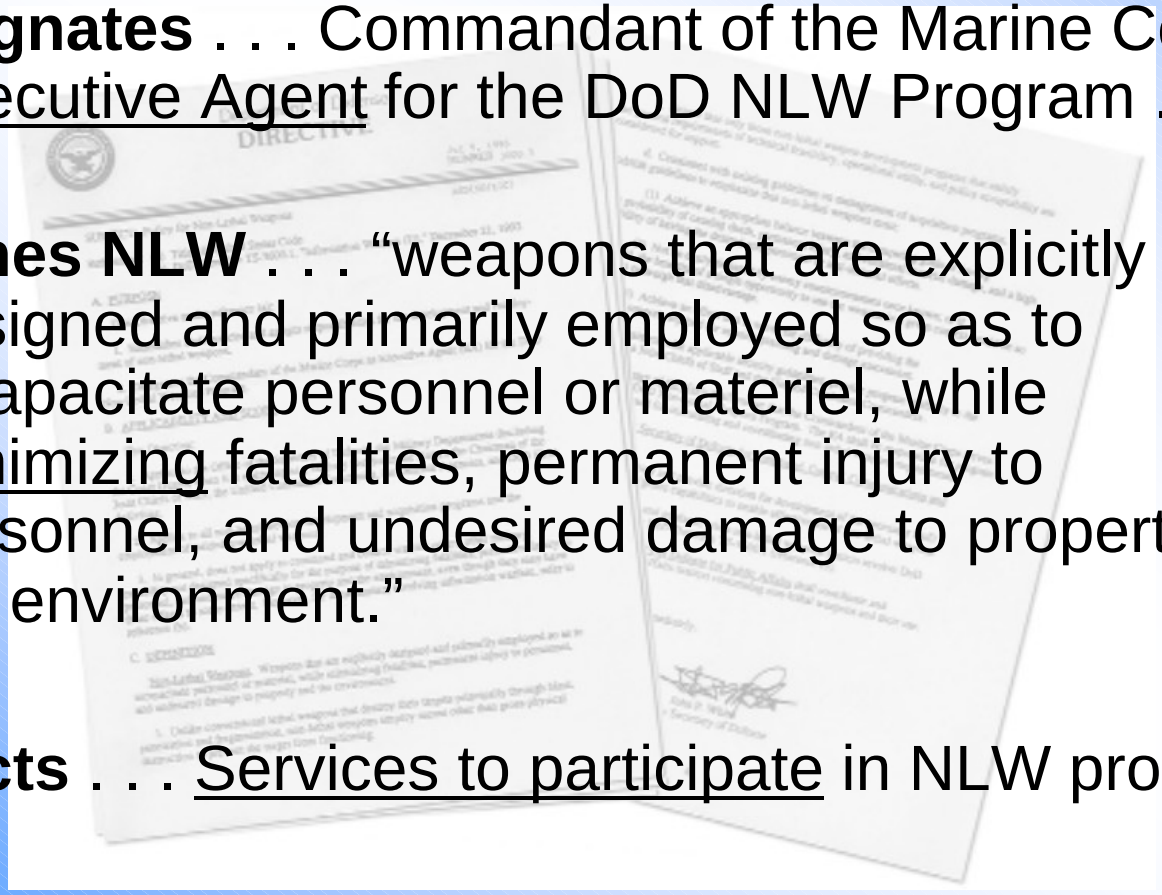
DoD Directive 3000.3, 9 Jul 96

Policy for Non-lethal Weapons (NLW)

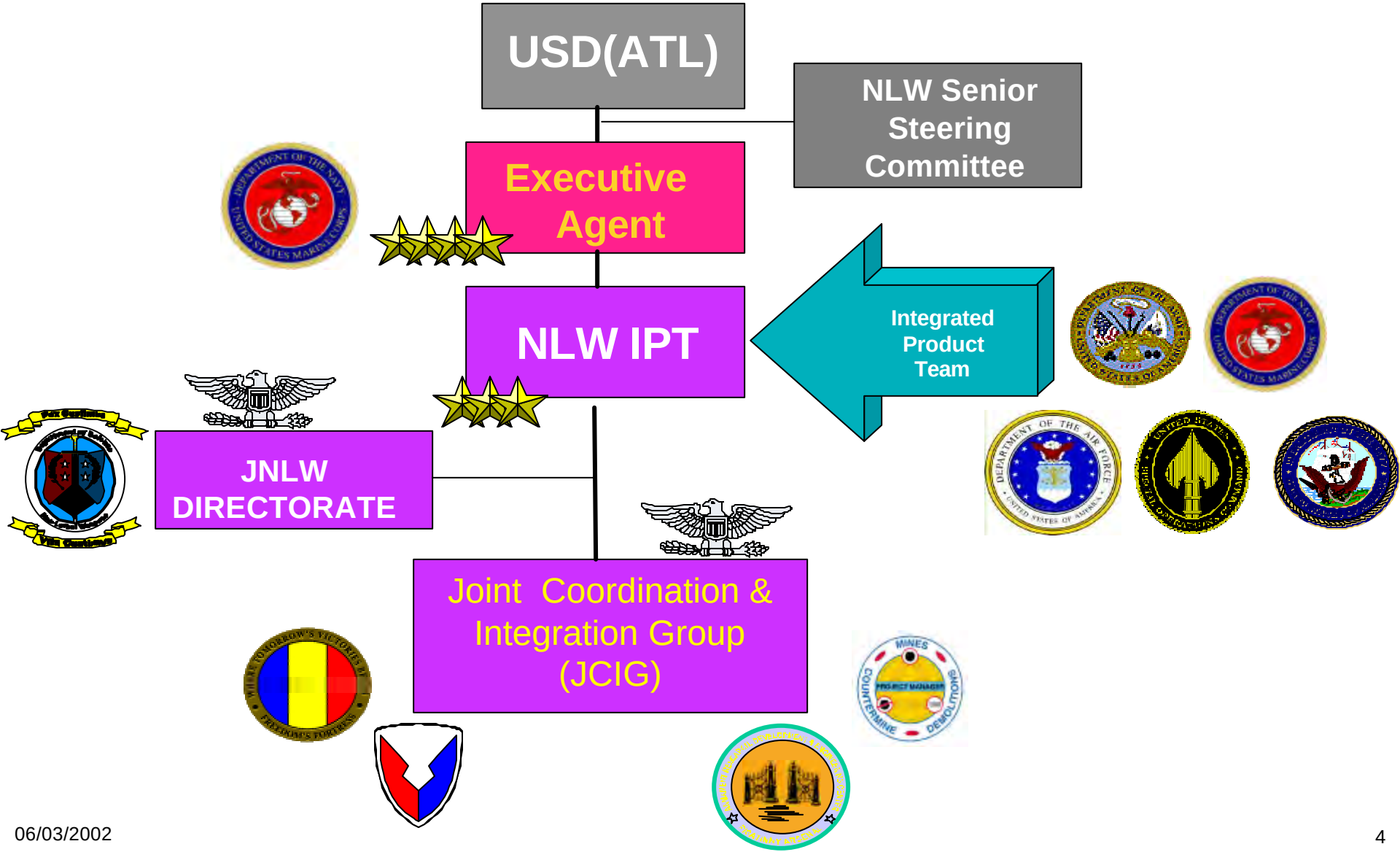
. . . **Designates** . . . Commandant of the Marine Corps Executive Agent for the DoD NLW Program . .

. . . **Defines NLW** . . . "weapons that are explicitly designed and primarily employed so as to incapacitate personnel or materiel, while minimizing fatalities, permanent injury to personnel, and undesired damage to property and the environment."

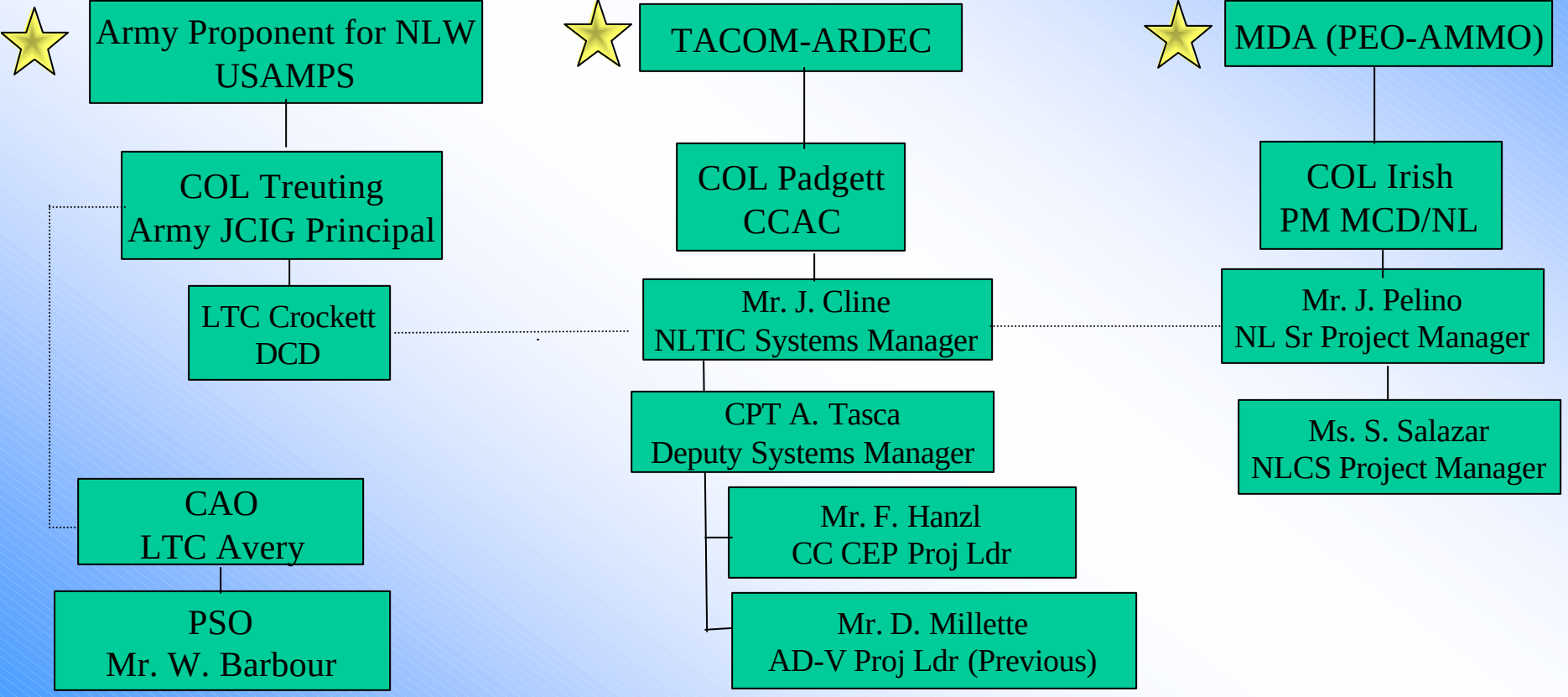
. . . **Directs** . . . Services to participate in NLW program



DoD Joint Non-Lethal Weapons Program



Army NL Organizational Structure



DoD Joint NLW
Core Capabilities & Functional Areas
- Joint Mission Area Analysis (JMAA) -

DOD 3000.3: Policy for Non-Lethal Weapons - "NL Weapons are explicitly designed and primarily employed so as to incapacitate personnel or materiel, while minimizing fatalities, permanent injury to personnel, and undesired damage to property and the environment."



Counter-Personnel*

- *Crowd Control*
- Incapacitate Ind'l Personnel
- Denial of Area to Personnel
- Clear Facilities & Structure of Personnel



Counter-Materiel*

- *Area Denial to Vehicles*
- Disable/Neutralize Equipment





*** Functional Areas / Tasks Prioritized by <u>all</u> CINCs at 1996 DoD NLW User's Conference; Joint Concept for NLW's & Per JMAA Jan 2000**

Crowd Control CEP







USER PAYOFF -Primary Mission Tasks

- Contain or stop the crowd from advancing
- Disperse a crowd between 50-1000 meters
- Direct the crowd movement
- Isolate specific individual(s) within a crowd
- Separate Belligerents
- Disperse a crowd within 0-50 meters

DESCRIPTION

- Joint NLWP formal Phase A CEP assigned to Army as lead
- Identify, analyze and evaluate alternative concepts that satisfy selected NL Crowd Control mission tasks

MILESTONES

MNS approved	Oct 96 (Army)	☑
	Mar 96 (USMC)	☑
Joint MNS (draft)	pending	☐
Milestone A	2QFY01	☑
Phase A Decision Rev	3QFY03	☐

Crowd Control CEP
Program Description

Program Description: Identify, develop, and evaluate alternative system concepts that satisfy the jointly scoped mission tasks of the Crowd Control NL functional area.

Primary Mission Tasks:

- Contain or stop the crowd from advancing
- Disperse a crowd between 50-1000 meters
- Direct the crowd movement
- Isolate specific individual(s) within a crowd
- Separate Belligerents
- Disperse a crowd within 0-50 meters



Secondary Mission Tasks:

- Resolve "Human Shields" situations
- Channelize or isolate the crowd
- Tag/Mark the crowd from the ground

Crowd Control CEP
Operational Context & Capabilities

CROWD CHARACTERISTICS

- Crowd Size
- Crowd Motivation
- Crowd Composition
- Crowd Concentration & Area
- Crowd's Armament

OPERATIONAL CAPABILITIES

- Effectiveness
- Length of Effectiveness
- Speed of Effectiveness
- Weight
- Range
- Accuracy





CC CEP Operational Context
Crowd Characteristics

- **Crowd Size**: A group of 30 to 1000 people

- **Crowd Motivation**: Motivation is considered more significant than numerical size of a group.

  Four levels of crowd motivation to be considered:

  - **Casual** - No common bond within the crowd, requires space and people (i.e. outdoor mall)
  - **Sighting** - Similar to Casual Crowd, both have the two elements of people and space, requires a third element- an event. (i.e. fire, crime, accident, concert, ball game)
  - **Agitated -** Elements of a Sighting Crowd, but includes the element of a heightened state of emotion.
  - **Mob -** Has the elements of people, space, event, emotions, and physical activity, but is characterized by hostility and aggression.

- **Crowd Composition**: A representative figure for the composition of a crowd is 70% male/30% female with all age groups, to include minors reflected.

CC CEP Operational Context
Crowd Characteristics (cont)

- **Crowd Concentration & Area**: The concentration or number of people per square meter (m^2).

  Three categories designed on the basis of the density of people per square meter:

  - **Light Crowd** — 1 person per square meter
  - **Medium Crowd** — 3 people per square meter
  - **Heavy Crowd** — 4 people per square meter

  The area can be as small as 25 m^2 for a heavy crowd of 100 people to as large as 1000 m^2 for a light crowd of 1000 people.

- **Crowd's Armament**: Crowds will be armed with objects readily at hand including metal shields (garbage can lids) for defense and rocks, pipes, bats, and molotov cocktails as offensive weapons. The presence of armed militants is a separate consideration.



CC CEP Operational Characteristics

- Effectiveness:
  - Not applicable against a casual crowd.
  - Shall influence 99% of the sighting crowd.
  - Shall influence 85% of the agitated crowd.
  - Shall influence 80% of the mob crowd.

- **Length of Effectiveness**: Minimum effectiveness is not less than 10 minutes, but desired effectiveness of 12 minutes or longer. Injuries requiring prolonged or extensive medical treatment must be excluded.

- **Speed of Effectiveness**: Preference is for near instantaneous effect and minimizing onset time is critical. For guidance an interim goal is three (3) minutes.

CC CEP Operational Characteristics (cont)

- **Weight**: For systems, minimizing weight must be considered with a goal of:
  - not heavier than 35 pounds for man portable items
  - no more than 1100 pounds for HMMWV
  - no more than 2500 pounds for HMMWV trailer



- **Range**: Desired effective range is:
  0-100 meters for point engagement
  50-1000 meters for area targets

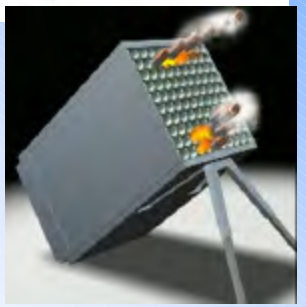
- **Accuracy**:
  - For a point engagement capability, selected target must be engaged at ranges up to 100 meters with 95% or greater probability of hit, excluding human factors.
  - For an area engagement capability, +/- 25 meters from point of impact is the goal if appropriate.

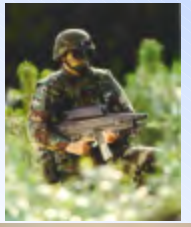
Example CC CEP Candidate Technologies

- Barriers
- Sound
- Air Vortices
- Temperature
- Water
- Visual Dazzlers (Light, Lasers
- Chemicals:
  - RCA Type (Malodorants, Irritants, etc.)
  - Other (Anti-Traction Materials)
- Directed Energy (Laser, Millimeter Wave)
- Electric Stun
- Enhanced Blunt Impact
- Combined Effects (Multi-Sensory, Flash/Bang, etc.)
- Legacy & Objective Force Delivery Platforms

  M16/ M4, M203, MK19, 60 & 81mm Mortars, etc.
- Other Platform Capabilities (Robots, UAV/UGVs)

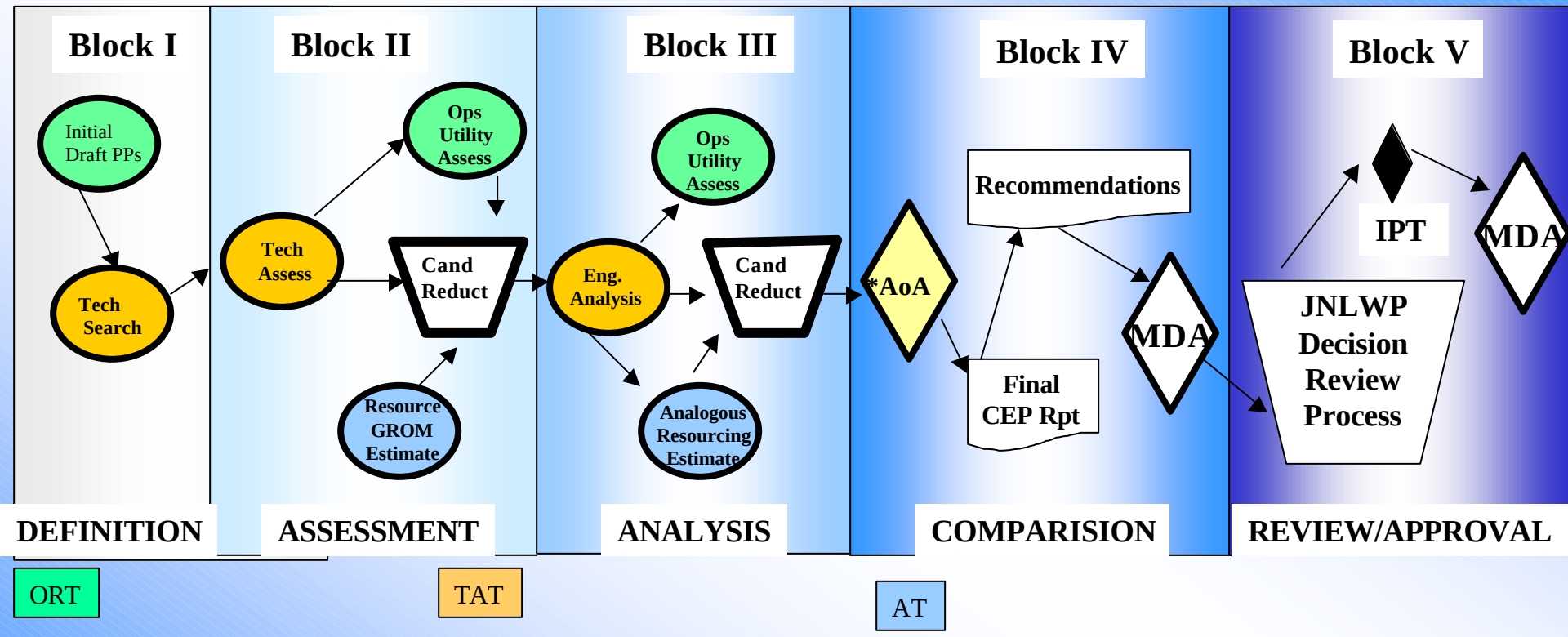






Generic CEP Process (CC & AD-V)



***AoA (Analysis of Alternatives) or Analysis of Multiple Concepts (AoMC)**

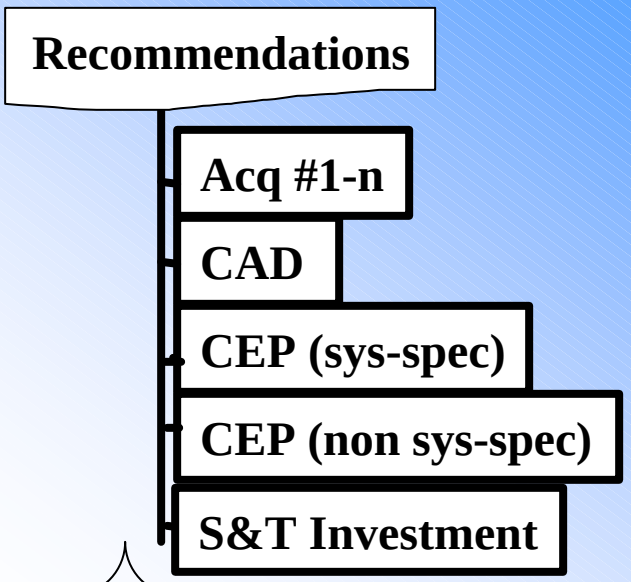
CEP Teams & Deliverables

Operational Requirements Team

- Operational Concept
- Desired Performance Characteristics
- Simulation Support Plan
- Performance Parameters
- Initial Key Performance Parameters
- Scenarios/Vignettes
- Measures of Effectiveness (MOE)
- Operational Utility Analysis
- Threat Assessment Report
- Draft Operational Requirements Document

Technical Architecture Team

- BAA & MS A package
- Measures of Performance (MOPs)
- M&S Study Plan - Feeder Data
- Preliminary Human Effects Assessment
- Technical Risk Identification & Mitigation
- Technology Search, assessment and analysis of candidate systems



Acquisition Team

- Resource Estimation Reports
- Draft Acquisition Program Baseline
- Draft Acquisition Strategy Report
- Life Cycle Cost Estimates
- Prelim Test and Evaluation Master Plan
- Exit Criteria
- Preliminary Legal Review
- Programmatic Risk Management Plan
- Integrated Program Summary

Crowd Control CEP Challenges

- **Human Effects / Effectiveness**
  - Quantification & Validation of Target Effects on Humans of Candidate Technologies
    - Population Variation (Degree of Susceptibility)
  - Measurement & Determination of Operational Effectiveness.
- **Modeling & Simulation of Crowd Behavior / Response to Crowd Control Concept Systems**
  - Motivation Levels
  - Crowd Dynamics
- **Scenario Dependency**



Area Denial-Vehicles CEP







USER PAYOFF

Primary Mission Tasks

- Deny an area to land vehicles
- Stop a vehicle-urban/suburban environment
- Channelize vehicles
- Stop a vehicle-open/rural environment

DESCRIPTION

- Joint NLWP formal Phase A CEP assigned to Army as lead
- Identify, demonstrate, and evaluate alternative concepts that satisfy NL Area Denial to Vehicles mission tasks
- Not limited to pre-emplaced systems

MILESTONES

MNS approval	FY96	☑
Joint MNS (draft)	pending	
Milestone A	2Q FY01	☑
Phase A Decision Rev	3QFY03	☐

Area Denial to Vehicles CEP
Desired Operational Capability Parameters

- Area (Perimeter Distance, 5km Max)
- Target
  - Combat Vehicles
  - Large Vehicles (Up to 80,000 lbs)
  - Small Vehicles (< 8,000 lbs)
- Effectiveness
  - Breach Prevention with 90% probability up to 20 minute delay
- Speed & Duration of Effectiveness
- Sensory System
  - Alert Operators to Breach
- Operational Range
  - 0-300 meters (T)
- Emplacement Time
- Cyclic Engagement Rate
- System Weight
  - Man Portable (<35 lbs)
  - HMMWV Mtd (<1100 lb)
  - HMMWV Towed (< 2500 lb)
- Logistic Considerations
- Environmental Considerations
  - No lasting effects from use
- Reversibility of Effect(s)
- Avoidance of Collateral Damage & Fratricide
- Resistance to Countermeasures

Example Non-Lethal AD-V Candidate Technologies



Caltrops



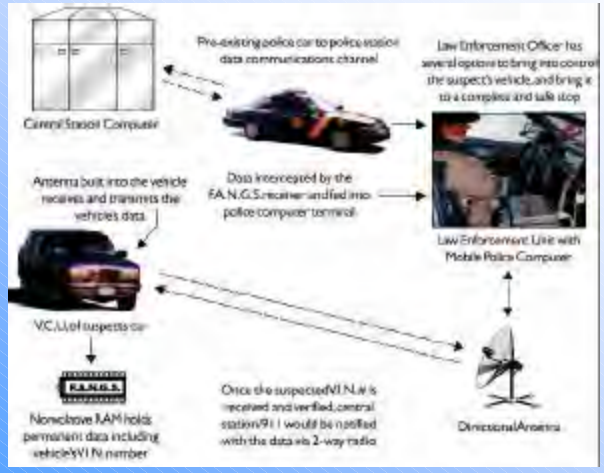
M1, Portable Vehicle Arresting Barrier, (PVAB)



Standoff Radio Frequency Ground Vehicle Stopper (ARL)

Anti-Traction Material (USMC)





Example "Cooperative System" -Frequency Activated Neutralizing Generator System (FANGS)

Fire Support Standoff Delivery Platform (w/ NL AD-V Payload)





Advanced Tactical Laser

AD-V CEP Challenges

- **Human Effects / Effectiveness**
  - Quantification & Validation of Target Effects on Humans resulting from use of potential Candidate Technologies
  - Measurement & Determination of Effectiveness

- **Scenario Dependency**
  - Class of Vehicle (Military / Commercial), Speed & Weight of Vehicle, Vehicle Prime Mover (Diesel, Combustion, Electric, Hybrid)
  - Terrain (Sand, Asphalt, Concrete, Icy Road, Urban vs. Rural Env't))
  - Collateral Damage (Uncontrolled Stops, Vehicle Fratricide, Self-Contamination)

- **Apparent Technology Limitations to Address Apparent Void for "<u>Ideal</u>" Operational Capability:**

  Portable, Hand-Held, Vehicle Stopper with Standoff Capability to Instantaneously Stop All Moving Vehicles with Reversible, NL Effects without any Collateral Damage or Environmental Degradation.

Summary

- **Numerous Urgent Fieldings have led to 1st Generation Crowd Control & Area Denial to Vehicles materiel items currently, or soon to be, in the Service's Non-Lethal Capabilities Sets**
  (*e.g., Blunt Impact Munitions & Caltrops*)

- **The JROC Approved DoD NLW JMAA conducted by the JNLWP is basis for the formal Concept Exploration Programs**

- **Purpose of CC & AD-V CEP's is determination of viable 2nd & 3rd generation NL Capabilities for Joint Service use**

- **CEP's are following JNLWD CEP Guide (Update in Process)**
  - **All CEP's affected by DoD 5000.2 Rewrite**

- **CEP's can result in any number of recommendations:**
  - **S&T investment is required;**
  - **Component Advanced Development is needed;**
  - **Mature technology with improved capability identified , Acquisition program(s) are recommended**

Back-Up Slide

CEP Decision Support Analysis (DSA) Process

- Decision Support and Analysis (DSA) process is being used in support of the NLW CC & AD-V Analysis of Aternatives (AoA) / Analysis of Multiple Concepts (AoMC)
  - First, a basic decision model or tree is developed;
  - Measures of Performance (MOP) & MOEs are developed by the Users.

- Models & Criteria definitions are established & agreed. A pair wise comparison of the criteria with respect to user "requirements" is conducted.

- The pair wise comparison is the heart of the DSA as it allows each service to define key issues, through open floor discussions, and place greater weight on the most important Measures of Performance and Measures of Effectiveness.

- All Information feeds into Analysis of Multiple Concepts. AoA/AoMC is not stand-alone at this early stage of CE since Performance Data is typically not sufficiently quantified , nor validated.

U.S. COAST GUARD

CURRENT & DESIRED COAST GUARD LETHAL & NONLETHAL CAPABILITIES



HOMELAND SECURITY ARMAMENT



- **HARBOR ENVIRONMENT**
  - **AUTOMATIC FIRE**
  - **ANTI-PERSONNEL WEAPON**
  - **USED FROM CG SMALL BOATS**
  - **SOME ANTI-MATERIEL CAPABILITY**
  - **250-400 YD EFFECTIVE RANGE**
  - **MINIMIZE COLLATERAL DAMAGE**

CURRENT NON-LETHAL CAPABILITIES

- **CG NON-LETHAL CAPABILITIES AUTHORIZED FOR:**
  - **COUNTERDRUG OPS**
  - **ALIEN MIGRANT INTERDICTION**
- **CURRENT CAPABILITIES**
  - **ANTI-MATERIEL**
    - **.50CAL PRECISION TARGETING ROUND**
    - **MANUALLY DEPLOYED ENTANGLEMENT NET**
  - **ANTI-PERSONNEL**
    - **12 GAUGE BLUNT TRAMA**



FUTURE NON-LETHAL CAPABILITIES

- NEAR TERM
  - ANTIMATERIEL
    - AUTOMATIC SURFACE AND AERIAL DEPLOYMENT OF ENTANGLMENT NETS
    - STATIC BARRIER ENTANGLEMENT NET
    - 12GA ENGINE DISABLER ROUNDS
    - SPEED INHIBITORS
  - ANTIPERSONNEL
    - 12GA OC ROUND



DESIRED CAPABILITIES

- **LONGER-RANGED ANTIPERSONNEL NLWs**
- **LONGER-RANGED NLWs TO STOP PLANING HULL CRAFT**
- **ANTIPERSONNEL NLWs CAPABLE OF ACCURATE DELIVERY FROM A HELICOPTER**



DESIRED CAPABILITIES

- **MORE EFFECTIVE CROWD CONTROL NLWs**
- **NLW AGAINST PEOPLE IN THE WATER**
- **NLWs AGAINST JETSKIS**
- **NLWs TO STOP LARGE DISPLACEMENT HULL SHIPS**





The Future – 62 Lbs (w/62 Rounds

ADVANCED DEVICE DESIGN
CARBINE CONVERSION



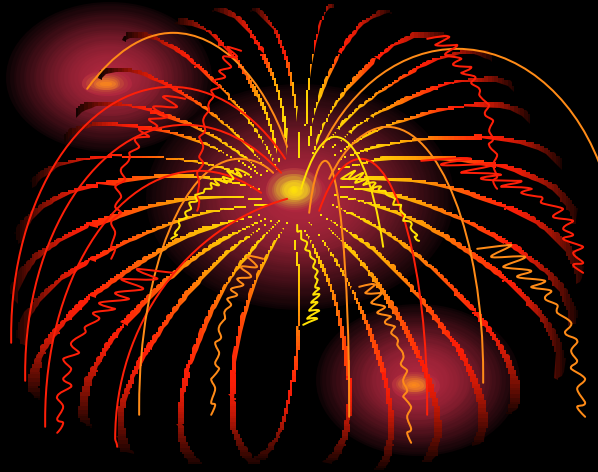
By
Charles Cutshaw

ADD CARBINE CONVERSION



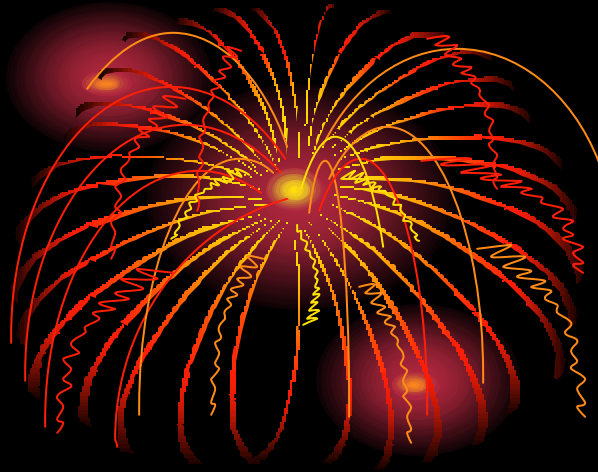
- Free float barrel
- New operating system
- Reduced cyclic rate
- Enhanced heat dissipation
- Improved muzzle brake
- Improved reliability
- Enhanced Maintainability

ADD HANDGUARD RAIL SYSTEM



- Mounts to MIL-STD-1913 upper
- Full-length MIL-STD-1913 top rail
- MIL-STD-1913 side & bottom rails
- Free-Floats barrel

NEW OPERATING SYSTEM



- M14 Based gas tube & piston
- SKS-type operating rod
- Adjustable gas port
- Bolt carrier counter weights
- Hydraulic buffer

OPERATING SYSTEM ADVANTAGES



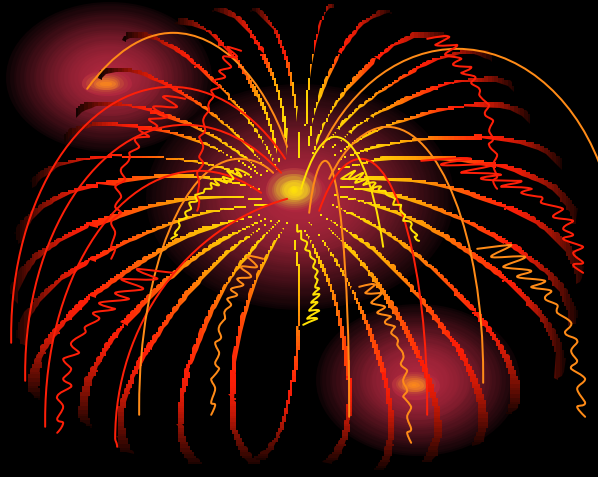
- Felt recoil reduced
- Gas rings eliminated
- Muzzle climb virtually eliminated
- Receiver fouling eliminated
- Cyclic rate reduced to 600-650 rounds/minute
- Controllability greatly enhanced

HEAT DISSIPATION



- Aluminum heat sink
- Airflow Enhanced cooling
- Passed non-stop 450 round full auto torture test
  - 30 rd bursts
  - Hand guard only warm
  - No effect on optics or accessories
  - Barrel remained within specs

MUZZLE BRAKE



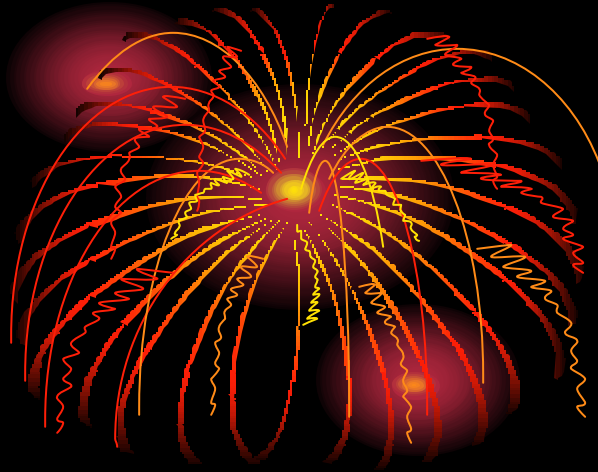
- Balanced pressure design
- No effect on accuracy
- Enhanced Flash suppression
- Standard Threads for existing muzzle devices

MAINTAINABILITY RELIABILITY ENHANCEMENTS



- Gas tube eliminated
- Gas rings eliminated
- Barrel life improved No receiver fouling or carbon buildup
- Barrel life improved

OTHER ENHANCEMENTS



- Accuracy speaks fire control
  - 4.0 lb semi-auto pull
  - 6.0 lb full auto pull
  - Clean “break”
  - No creep
- AMBI-CATCH magazine release

THE HORUS VISION SIGHTING SYSTEM



Presented by

Charles Q. Cutshaw

SHOOTING with the HORUS SYSTEM

To shoot at long range, the rifleman must know:

- Distance to the target
- Ballistics of the cartridge in the rifle
- “Come-ups,” to compensate for bullet drop
- Windage Corrections
- Correction for uphill or downhill shooting

Horus - Works with any caliber

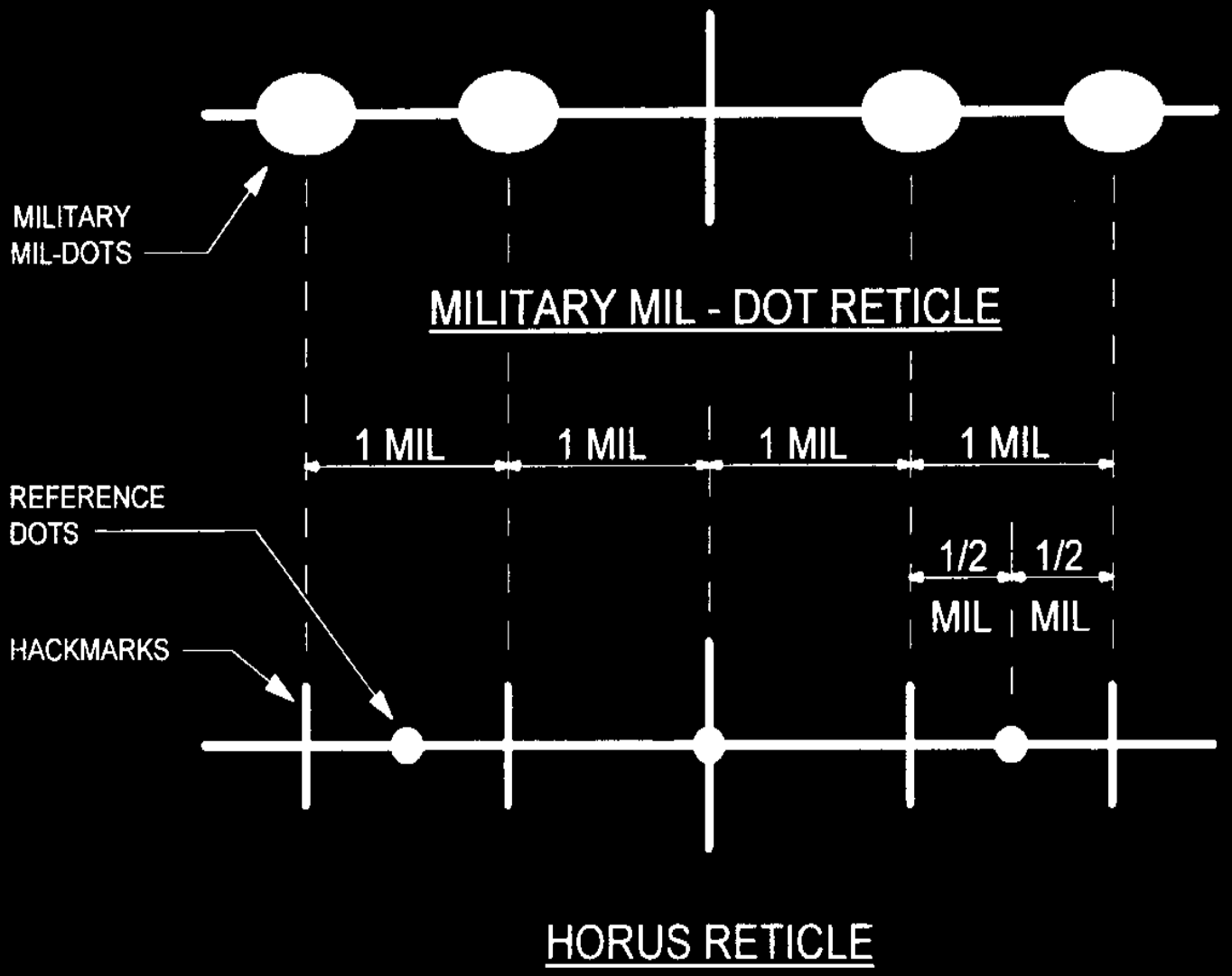


- Bullet drop compensation is computer calculated for specific caliber & load.
- Functions from 5.56 mm to 50 BMG

HORUS VISION SIGHTING SYSTEM – 21st Century

- The Horus Reticle brings current MIL-DOTS into the 21st Century.
- Because Horus is in 1st focal plane, it works at any magnification.

HORUS RETICLE MIL DOTS



HORUS RETICLE

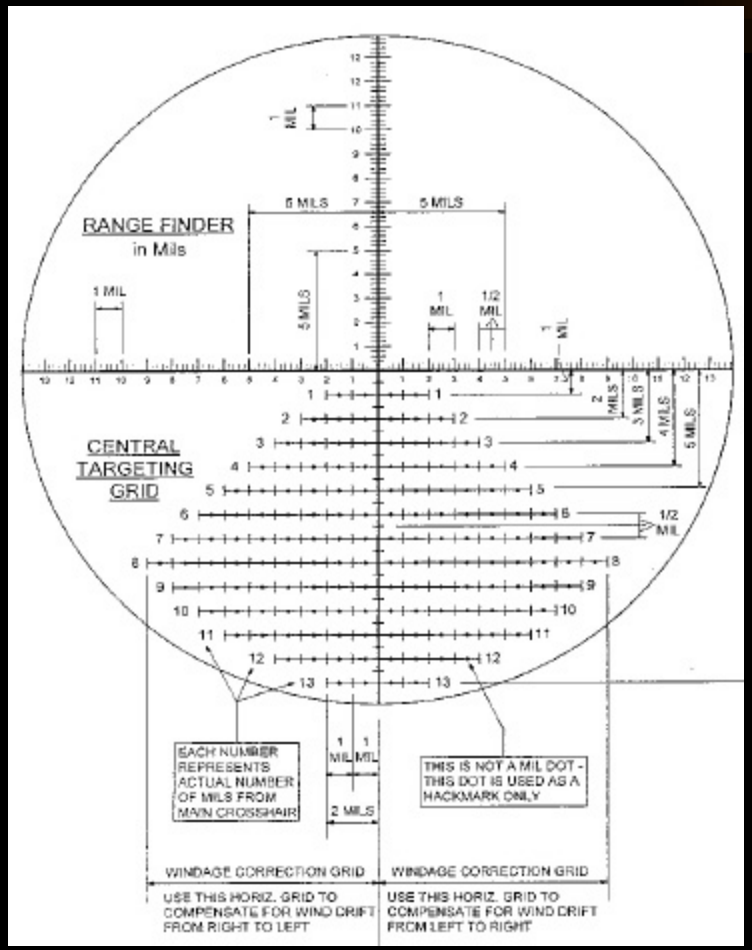
Horus Vision Features

- Mil-Dot Based
- Much more precise than current Mil-Dots
- Faster ranging and targeting than current Mil-Dots
- Dialed in “come-ups” eliminated
- Training time reduced
- Ranging possible @ any magnification

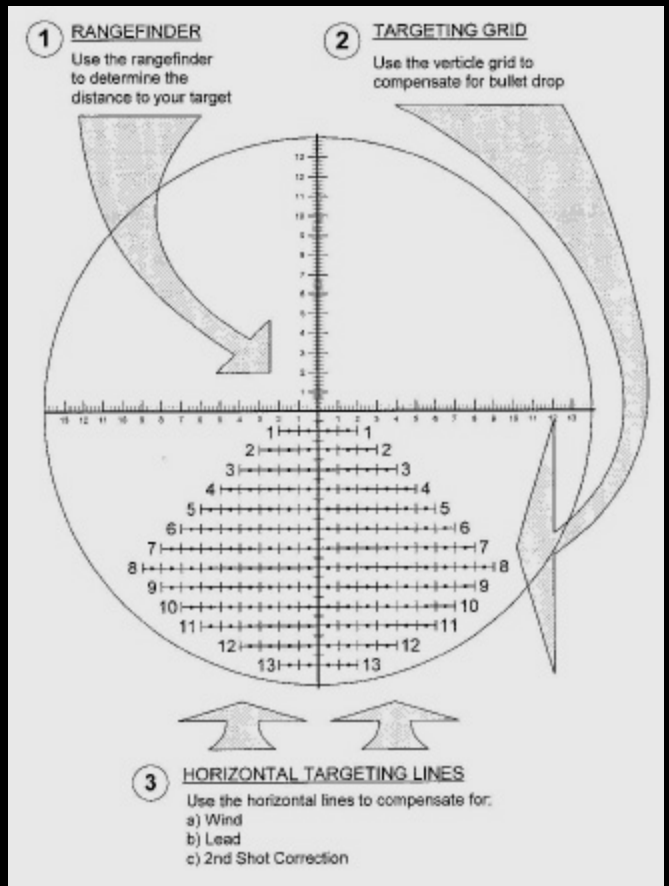
The Horus Reticle

- The reticle is composed of two parts:
  - The Range Finder
  - The Targeting Grid
- Both calibrated in USMC MILS
- Range finder accurately measures to .10 of a MIL
- Central targeting grid provides for elevation adjustment.
- Wind deflection allows for 20-30 mph full value wind correction
- Lead on moving targets
- Second shot correction.

SPECIFICATIONS



HORUS TARGETING



Horus – Total Sighting System

- Scope & Mounts
- Handheld computer
- PC Software
- Pocket metrological station

Horus Vision Mission Essential Components

- Scope & Mounts
- Range Card - “Cheat Sheet”

Top-Gun Technologies, Inc. Firearm Finishing Processes

Presented by
Ollie Daw, COO

Top-Gun: Metal Finish Process Not a Coating



Problems with Current Processes

- Surface corrosion on Parkerized and Black Oxide
- Non-uniform color
- Delamination of polymer coatings (Teflon)
- Delamination of Plated Surfaces
- Uneven deposition of hard chrome place

Current Problems Con't

- Stainless steel suffers from corrosion
- Cost (Stainless Steel, Titanium)
- EPA hazards (chrome plating processes)
- Plating process reduces material strength.

Contrast in Effectiveness



Stealth-Tech Advanced Gun Finish Process

- Corrosion protection to 100% of metal surfaces including the barrel bore.
- All of the advantages of the popular process without the typical problems
- Reduces wear – dry film lubricants impregnated into the metal including the bore

Stealth-Tech Advanced Finish Process (Con't)

- More durable and reliable than Teflon coatings, Parkerizing or black oxide
- Applied to all metal surfaces, including carbon steel, aluminum and stainless steel.

Alabama Marine Police Top-Gun Exclusively



- Hostile environment
- Maintenance reduced: cost & time
- Extended service life of equipment

Ultra-Tech Advanced Gun Finish Process

- All of the advantages of Stealth-Tech process plus improved corrosion resistance and wear resistance
- Parts can be made to size then processed without allowance for plating thickness or excessive nitride growth

Ultra-Tech Advanced Process Con't

- Normalies and stress relieves barrels providing consistent shot grouping
- Uniform surface, not possible with hard chrome plating
- Will not de-laminate as the metal is transformed rather than plated

Ultra-Tech Advanced Process Con't

- Better corrosion resistance from chrome moly steel than possible with stainless steel –increases fatigue and tensile strength
- Superior wear resistance & reduced friction (Rockwell Hardness C58 – C61)

Precision Airdrop Infantry Resupply

Key Emerging Technology Area for Objective Force Sustainment

Smart Airdrop from High Altitude and when required, significantly offset from the Drop Zone

- Pinpoint, Just-in-Time Airdrop
- Eliminate Aircraft Vulnerability
- Eliminate Drop Zone Detectability

Edward Doucette
Director, Airdrop/Aerial Delivery Directorate
U.S. Army Natick Soldier Center

What Is Precision Airdrop?



- Family of Parachutes and Control Systems (based on weight)
- Common Navigation System

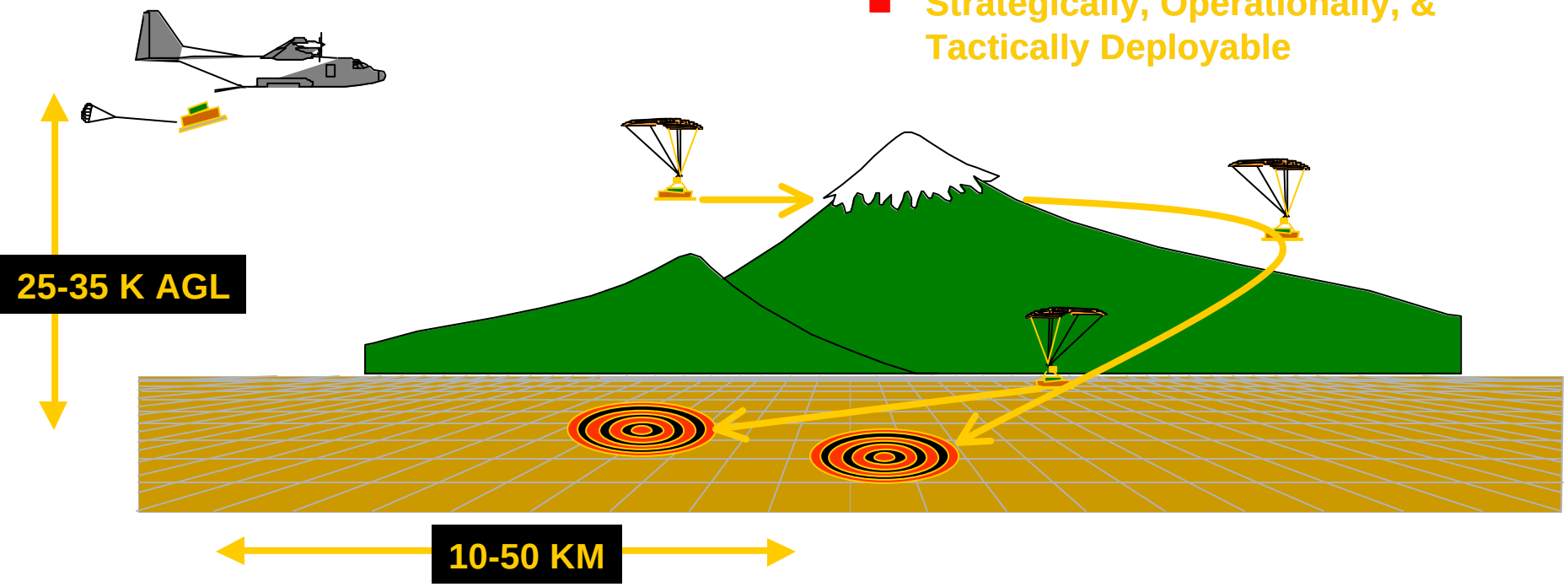
RIGGED LOAD

- Standard Bundle
- Standard Pallet
- New technology?

Benefits of Precision Airdrop

- ***Increased USAF Survivability***
- **High Altitude Deployment 25-35 K FT**
- **Offset/Standoff 15-50 KM**
- **Autonomous Operation**
- **Compensates for CARP Errors**

- ***Rapid Resupply Over Strategic Distances***
- **Increased Accuracy (25-100 M CEP)**
- **Multiple Loads/Multiple Destinations**
- **Major Sustainment Enabler and Footprint Reducer**
- **Strategically, Operationally, & Tactically Deployable**



Future Precision Aerial Resupply Family of Systems

- Precision Gliding Airdrop
- High Altitude, Precision Container Delivery Airdrop
- Powered, Extended Offset Precision







Objective Force Aerial Resupply

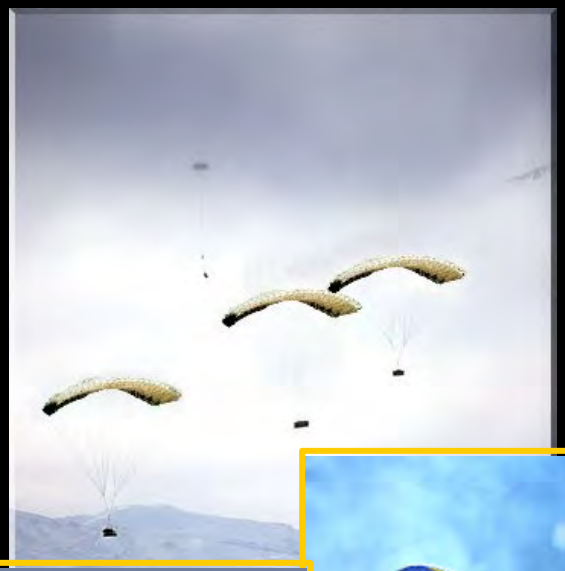
Autonomous, Remote Delivery of Sensors, Munitions & Equipment to Multiple Drop Sites

Powered Parafoil Resupply



Technology Focus Area
Aerodynamic Decelerators

- Gliding parachutes
  - Parafoils
  - Paragliders
- Deployable semi-rigid and rigid wings

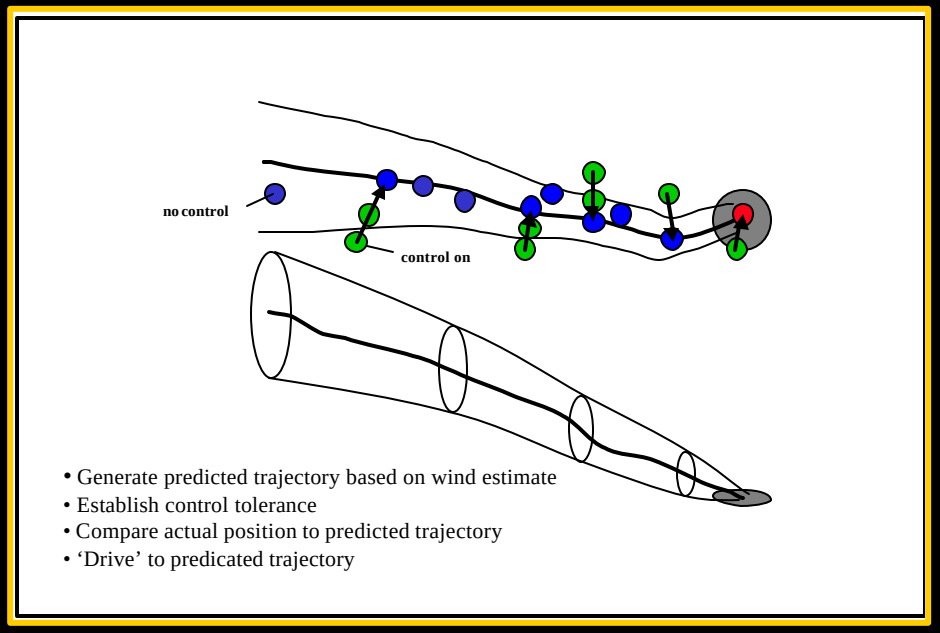






Technology Focus Area
Sensors & Actuators

- Guidance, Navigation and Control
- Ground proximity/height sensing
- Weather/wind sensing
- Autonomous steering





Technology Focus Area
Powered Precision System Integration





Technology Focus Area
Airdrop System Modeling

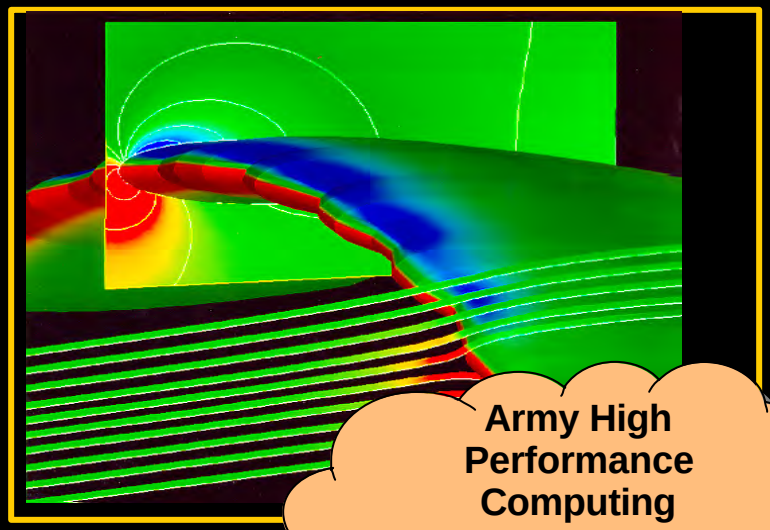
Army's Airdrop Modeling Vision:

Meet challenge of Airborne Virtual Proving Ground

- **Analytical prediction of parachute performance.**
- **Optimize parachute designs for higher performance and reduced life cycle cost.**
- **Decrease RDTE costs and time to fielding new airdrop systems.**
- **Develop high fidelity parachute computer models for design trade-offs and virtual testing /experimentation.**
- **Wind/weather prediction (leveraged)**

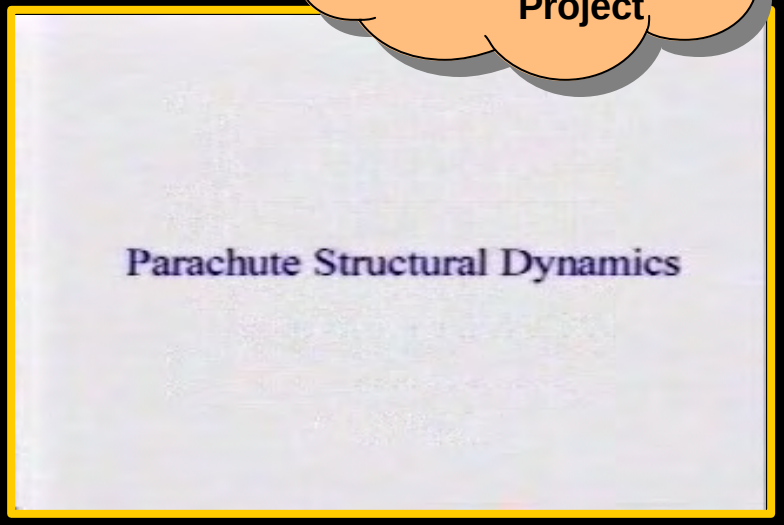
Technical Approach:

- **Numerically predict parachute opening and steady state characteristics, Model Fluid-Structure Interaction**
- **Numerically Couple Modified Computational Fluid Dynamics (CFD) and Structural Dynamics Codes**
- **Leveraging of outside organizations (Rice U, UCONN, NASA-JSC, AHPCRC, ARO,, ARL,)**



Army High Performance Computing

Grand Challenge Project



FCS Precision Resupply Animation



Leaflet Delivery Animation



Precision Airdrop Infantry Resupply

TODAY

- 2200 Lb Payload Capacity Gliding Offset Systems
- 600 Lbs Powered Parafoil

FY08

- 10K Lbs Gliding Offset System
- 2K-10K Lbs Low Cost, High Altitude Precision

POCKET LASER RANGEFINDER UPDATE

2002 International Infantry & Small Arms Symposium

May 16, 2002

William Dunnill

Jos van Seeters

Leica Technologies Inc
703-777-3900
bill.dunnill@lti.leica.com

Leica Geosystems

Outline

- Pocket Laser Rangefinder (PLRF)
- Viper/Vector IV
- Vector 21
- Vector N (Night)
- Laser Rangefinder/Digital Magnetic Compass Module

Leica
Geosystems

Leica LRF Products Supporting Small Arms Users



VIPER/VECTOR POCKET LRF LRF/DMC MODULE

Leica Geosystems

LEICA PLRF - Pocket Laser Rangefinder



- Pocket LRF Range > 1km
- Class 1 eye safe
- Size (4.5 x 3.7 x 1.7 inch)
- Handheld (17 oz)
- 6 x 28 Monocular
- Button operated
- Adaptation to NV
- IAW MIL-STD 810
- Submersible 66 ft
- > 5,000 shots, COTS battery

Leica
Geosystems

LEICA PLRF - General Characteristics

Rangefinder

- Range performance: 50 - 1000 m
  (albedo 0.1, target size 1 x 1 m, vis. 7 km)
- Measurement range: 5 - 2500 m
  (theoretical on display)
- Accuracy: ± 1 m
- Diode laser: 905 nm
  1550 nm
- Eye-safety: Class 1
  according to ANSI Z 136.1 (2000)



Leica Geosystems

PLRF - Status

- Oct. 4, 2000: Order for two 905 nm ETU (engineering test unit) USN Contract N00164-01-D-0004, delivery order 0001
  (delivered April 2001)

- Jan. 20, 2001: Order for two 1550 nm ETU, delivery order 0002
  (delivered July 2001)

- Feb. 14, 2002: Order for 523 1550 nm units, delivery order 0003
  (delivery to start August 2002)

Leica
Geosystems

LEICA VIPER/VECTOR IV Rangefinder Binoculars



- 7 x 42 Binocular Optics
- Rangefinder: 5 m to 4+ km
- Class 1 eye safe
- Gating, MOM
- Compass and Inclinometer
- Displays range, bearing, elevation, FO SV (8 meas. in total) in field of view
- Digital output via RS232, PLGR interface, SLP in process
- Auto boresight with NV equipment
- Floats and is waterproof
- >3000 measurements with COTS battery
- 3.7 lbs

Leica Geosystems

VECTOR/VIPER: Typical Applications



Snipers
Anti-tank Weapons
Range and elevation
First round hit
Optimal deployment





Scouts
Forward Observers
Mortar Fire Controllers
Engineers
Reconnaissance
Target acquisition
Rapid surveying
Digital data capture
Gap measurement



Leica Geosystems

Low Earth Orbit Position and Reporting Device (LEOPARD)



Assault Pack Capabilities

Viper Laser Range Finder
- Azimuth, Elevation & Distance
- 4.5km range
- +/- 1m accuracy

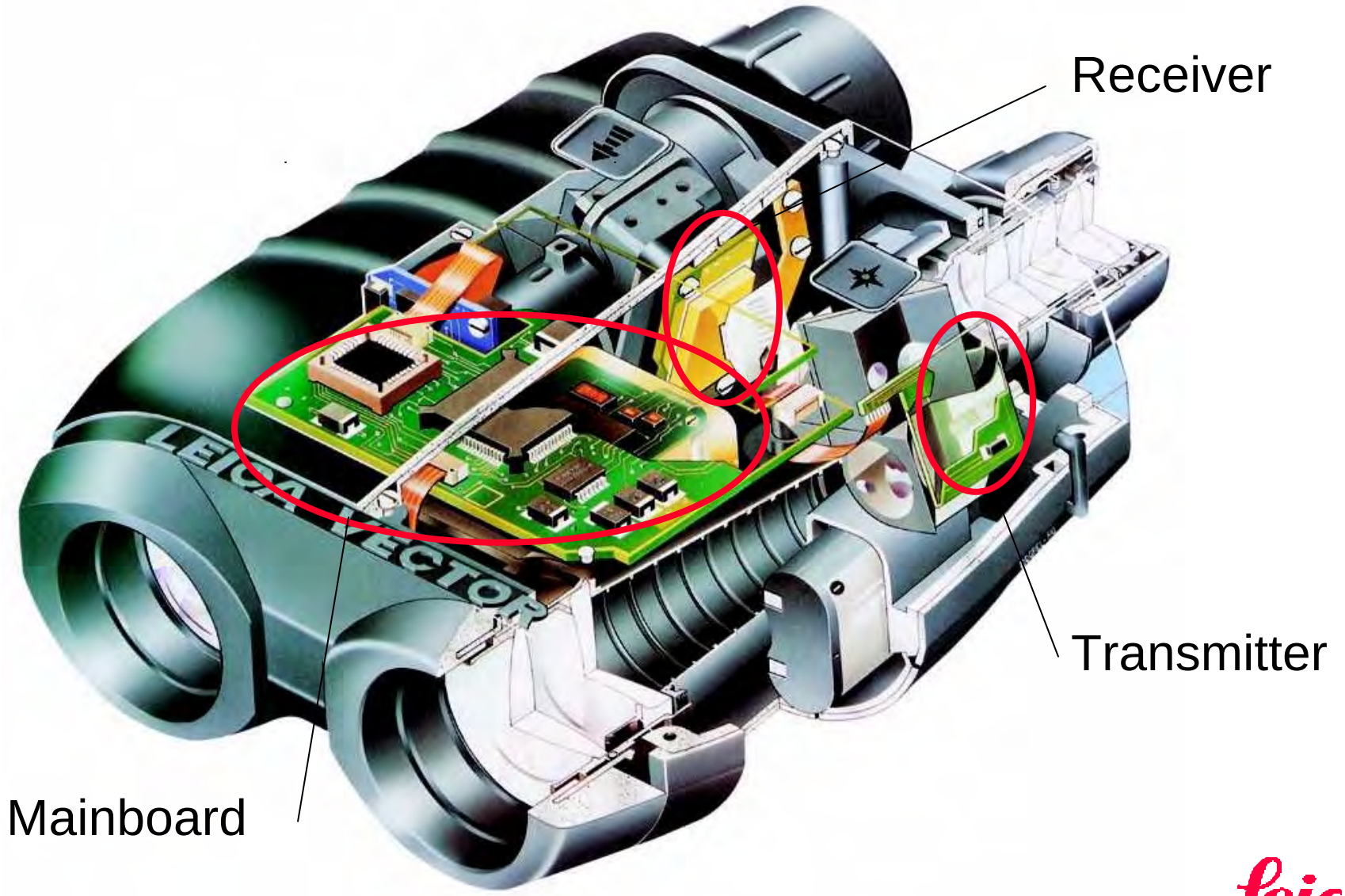
Palmtop
- GPS,Comms, Viper Interface
- Standard Mil Reporting Formats
- Common Operational Picture



Mobile Satellite Service Handset (Iridium)
- Voice and Data Capability
- 2400bps transmission rate
- Worldwide over-the-horizon coverage

PLGR II
- Provides 10 Digit Location
- Provides enemy location using the vipers

Modifications for the VECTOR 21



Leica Geosystems

Range Comparison, at Visibility of 10 km

Target,Albedo/Size	VIPER*	VECTOR 21*	Melios**
DPST 0.5/ 0.5m	1.5 km	2.8 km	2.8 km
NATO 0.2/ 2.3m	2.5 km	5.6 km	5.5 km
Tree 0.23/ 5m	4.0 km	7.8 km	7.6 km
House 0.35/10m	5.5 km	10.6 km	(10.0 km)

*verified with field measurements

**according to data sheet

Leica Geosystems

Vector 21 Range Measurements in Meters

Extended targets:
- 12,000, maximum
- 11,900, Mt. Scott, Ft. Sill (25 Oct 01), white house (Switzerland)
- >8,000, trees
- >7,000, slope with grass
- >4,000, slope with snow

NATO targets:
- 5,200, (2.3 x 2.3 m, 30% reflectivity; 2.3 x 4.6m, 20% reflectivity)*
- 8,100, tank
- 1,000, smoke test (could not see target) Ft. A. P. Hill (18 Oct 01)

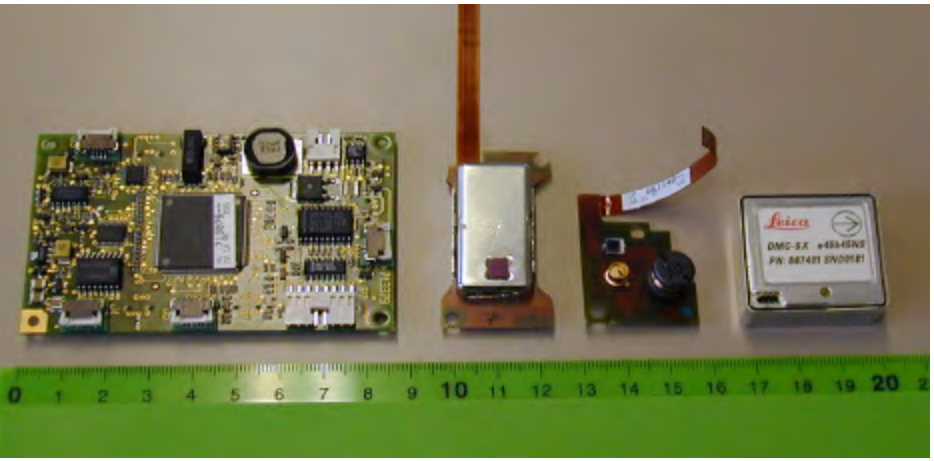
Man-sized
- 1,964 (10% reflectivity)*

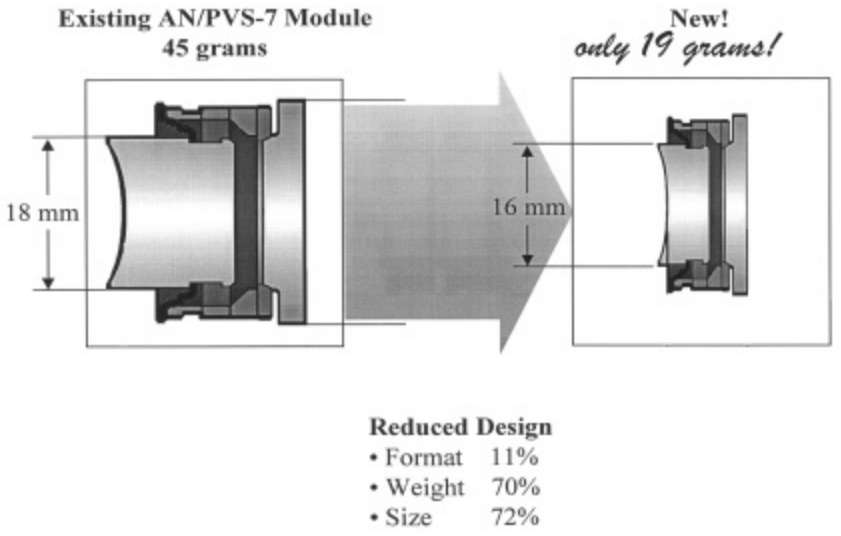
* Visibility <7 km

Leica Geosystems

VECTOR/VIPER with Integrated Night Vision

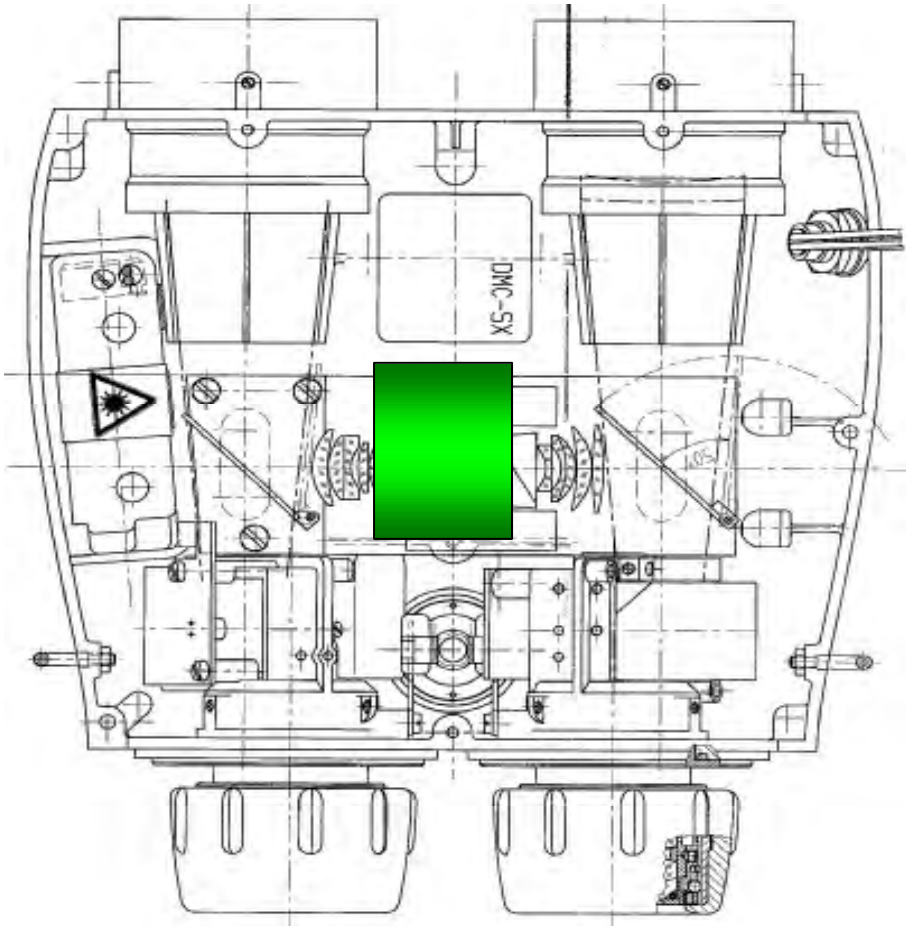
- Technological Enablers
  - breakthrough in miniaturization of Leica LRF technology
  - introduction of a new generation of Leica digital magnetic compass
  - availability of miniaturized image intensifier tubes





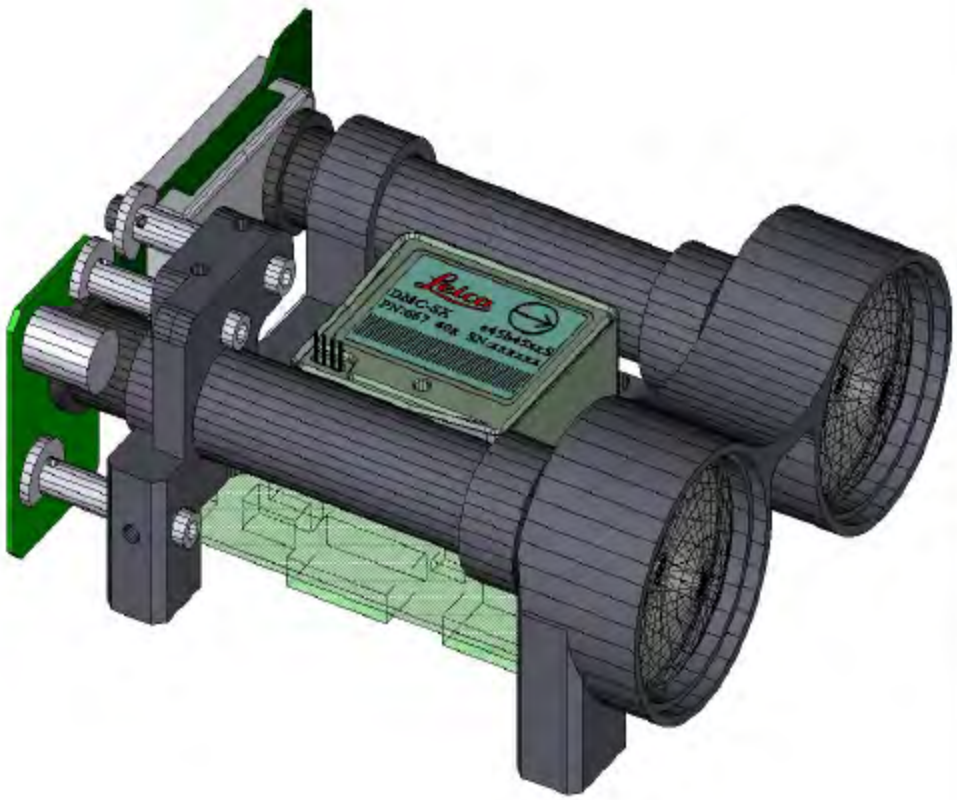
Leica Geosystems

VECTOR Night Layout



Leica
Geosystems

Laser Rangefinder/Digital Magnetic Compass Module



Range

- Ranges up to 2500/5000 m
- Wavelength 905 nm and 1550 nm
- Class 1 Eye Safe
  (ANSI Z136.1-2000 & EN 60825-1 1994)

Heading & 2-axis tilt

- Azimuth accuracy 0.5°, independent of elevation and bank positions
- Elevation and bank up to +/- 80°
- Built-in 3D magnetic compensation

Physical characteristics

- L x W x H: 3.9 x 3.1 x 1.7/4.3 x 3.9 x 2.0 in
- Weight (as shown): ≈ 8/12 oz.

Leica Geosystems

LRF-DMC Module, Top View



Leica Geosystems

MK47 and VIPER Operators

Leica LRF module in LVS



VIPER/VECTOR

Leica Geosystems

Programs Using Leica LRF Modules

US Programs

MK 47 Grenade Launcher (LVS)

MK 19 Grenade Launcher FCS (SAFCS II)

OICW (LRF short list)

Proposed Land Warrior MFLS

European Programs

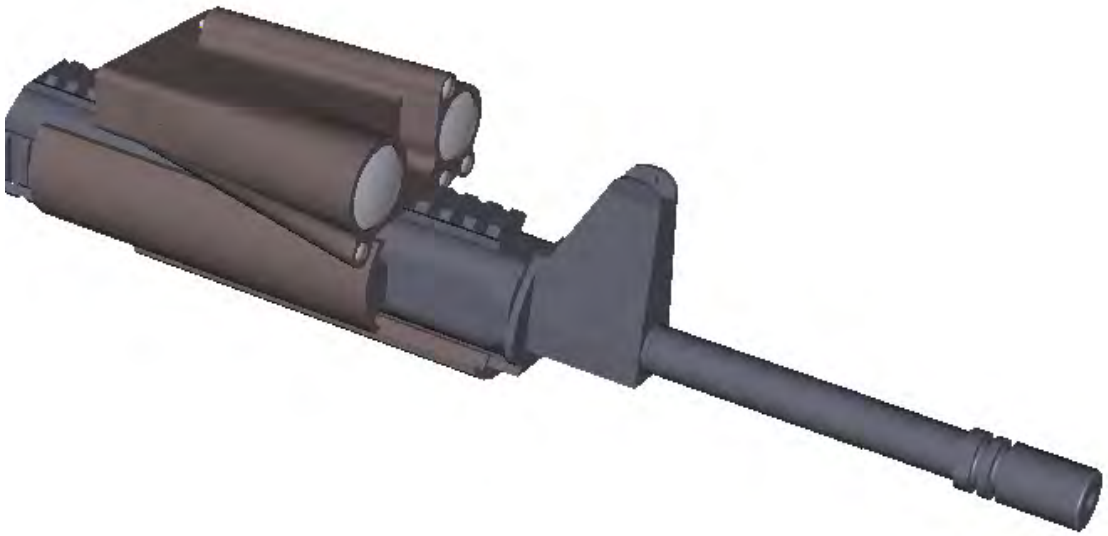
FIST (UK)

IdZ (Germany)

FALIN (France)

Leica Geosystems

Multi-Function Laser System



5 laser functions

CVAM

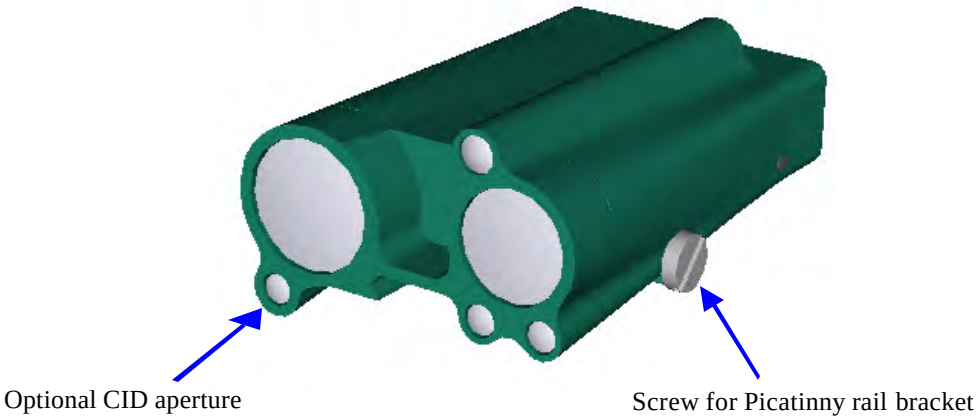
Optional CID

Weight ~ 16 oz

Dimensions ~ 4.7 x 3.7 x 1.9 in.

Leica Geosystems

Proposed Land Warrior MFLS



LRF: >2,500 meters

Visible Aiming Laser

NIR Aiming Laser

NIR Illumination Laser

TES (MILES)

CVAM

Leica Geosystems

Our Headquarters are in Switzerland's Rhine Valley



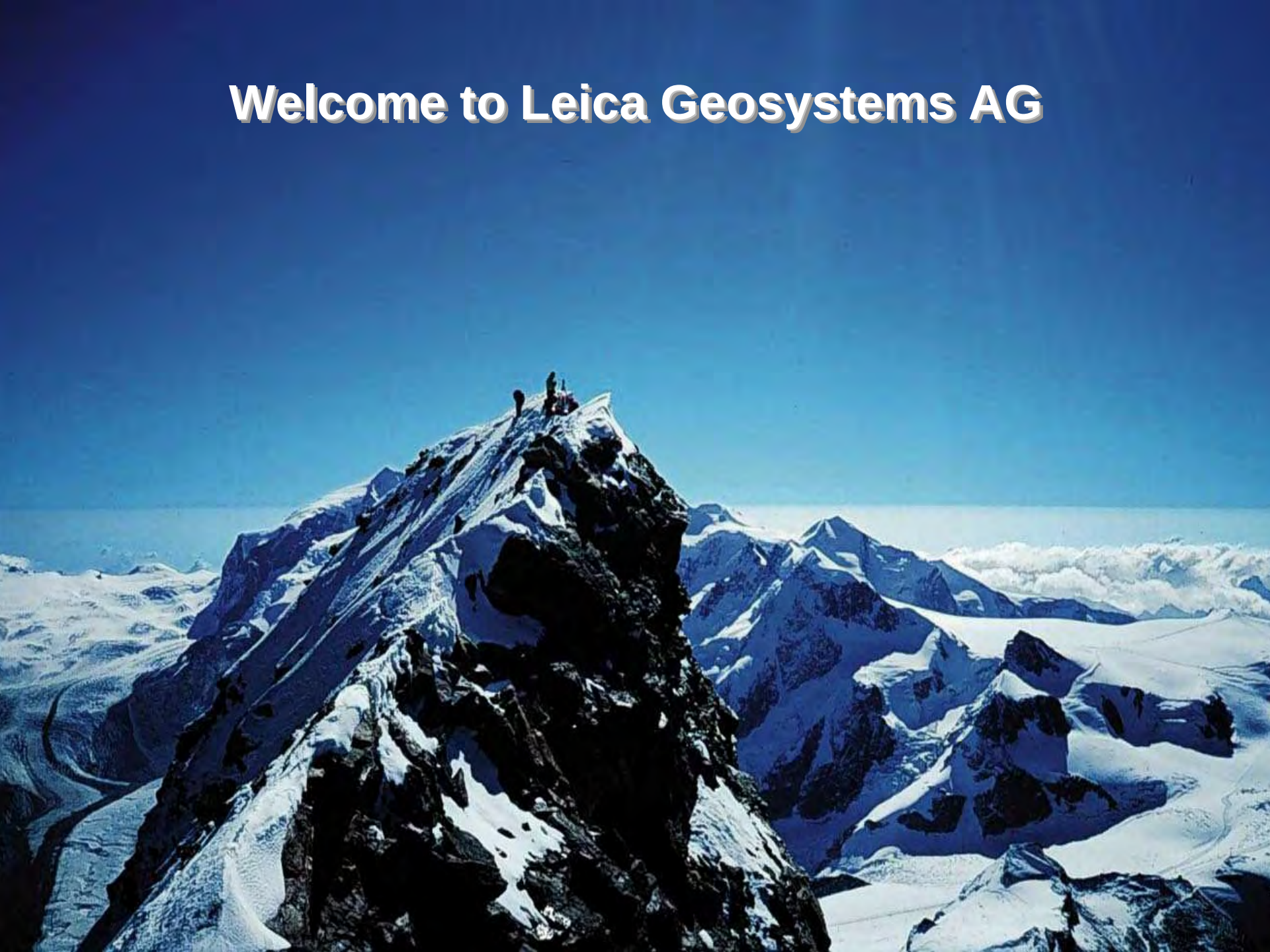
Heerbrugg, since 1921 (former Wild Heerbrugg)



Heerbrugg

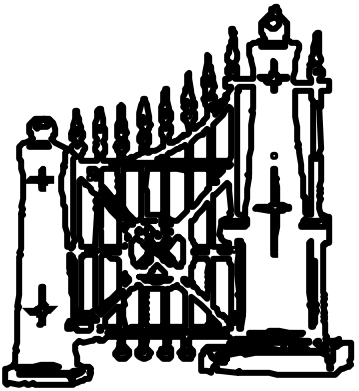
Leica
Geosystems

Welcome to Leica Geosystems AG

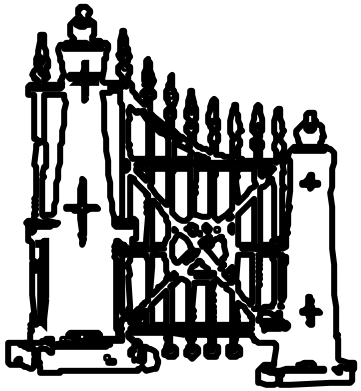


TACOM

Lethality, Survivability, Mobility and Sustainment for America's Army



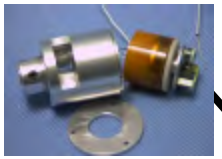
The Value of Systems Engineering and Integration in OCSW Development



John Edwards
TACOM-ARDEC

Objective Crew Served Weapon

Technology & Design Innovations



Mini Electronic Time Fuze w/ Point Detonating/Self Destruct Capability



Precision Air-Bursting 25 mm Munition, 2 km Range



Armor Piercing Munition

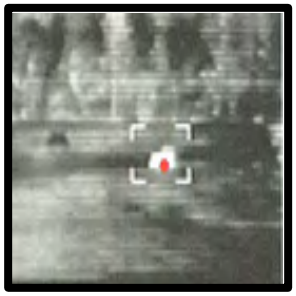


Ammunition Velocity Correction





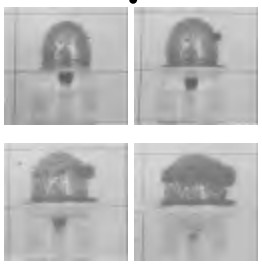
Impulse Averaging Soft Recoil (No Sandbags Required)



Thermal Target Tracker



OICW's 1 km Thermal Module



Controlled Fragmentation Warheads



Lightweight (< 38 lb) 2-man Portable System

OCSW ATD EXIT CRITERIA

Range Measurable

	BASELINE(S)			OCSW ATD	
I. LIGHTWEIGHT	**MK19**	**M2**	**M240B**	**THRESHOLD**	**GOAL**
-SystemWeight (no Ammo), Lbs	144lb	128 lb	43.4 lb	57 lb	38.6 lb
- Crew (2 Man) Portable Modules (Transport Module Weight w/ ammo), Lbs	76 lb	84 lb	24.2 lb	38 lb/person	35 lb/person
II. LETHALITY					
- Accuracy / Dispersion) (deflection error @ 600m)	-	-	-	2 mils	0.5 mils
- Fuze Function Set by Fire Control	N/A	N/A	N/A	Single Shot	Full Auto
- Air burst Point Range Error (known range, 600 m)	N/A	N/A	N/A	10 m (+/- 5m)	4 m (+/- 2m)
- Defeat of Defilade Target	Minimal	None	None	Yes	Yes
- High P(i) (*1)	x	y	z	3x / 12y / 8z	6x / 24y / 16 z
- Armor Penetration (at 0 deg. obliquity)	2"- 3" RHA @ 1,500 m	3/4" HHA @ 1,500 m	1/2" HHA @ 800 m	2" RHA (*2) 1,000 m	2" HHA (*2) 2,000 m
- P(h), Lt Vehicle Target @ 1,000m (Two 5 rd bursts; stationary 2.3 x 2.3m target)	-	-	-	.35	0.75
III. DAY / NIGHT CAPABILITY				1000 m	2,000 m
- Demonstrate Thermal Module				(modular interface to OCSW) (*3)	
IV. LAND WARRIOR COMPATIBILITY				LW Interoperable	LW Wireless Interoperability

Simulation Measurable

Based on Government approved Modeling & Simulation:

V. SURVIVABILITY					
- Casualty Reduction (*4)				40 % Reduction	90 % Reduction
VI. SUSTAINABILITY					
- Lbs Ammo/ "Kill" (*1)	111	117	25	20	6
VII. AFFORDABILITY					
- Cost /"Kill" (Ammo) (*1)	$1,420	$600	$130	$300	$130
- Design to Avg Unit Production Cost (HE Ctg)	$ 24 (15)	$ 2	$ .55	$ 29 (incl. Facility)	$ 22

* 1 - Weighted AMSAA Analytical Model: Avg: 200-2000m; Standing/Prone/Defilade (5/20/75 %). "Kill" refers to fraction of threat squad incapacitated; current systems have significantly less incapacitation capability against defilade targets. AMSAA model not representative of actual operational engagement scenarios.

Rev: 21 Jul 98
3/03/00 - JHE

* 2 - Test Warhead Only (no fuze). ORD will require 2" HHA capability.

* 3 - FUE Goal is 2,000 meter capable thermal module. ATD will assess weight vs. range of available uncooled thermal sensors.

* 4 - Reduction from small arms inflicted casualties in TRAC-WSMR CASTFOREM high resolution scenarios.

System Error Budget

OCCASION-TO-OCCASION

- Range determination error
- **Air Density** (Air Pressure & Air Temperature)
- **Coriolis (earth rate)** (Latitude & Firing Direction)
- Cant Angle
- Cant Zeroing
- Site Angle
- Site Angle Zeroing
- Muzzle Velocity Error (Temp.)
- Fire Control Solution
- Static Boresight (weapon)
- Static Boresight (FCS)
- Jump - Vertical
- Jump - Horizontal
- Gun Zeroing
- Cross Wind Velocity
- Cross Wind Direction
- Range Wind Velocity
- Range Wind Direction

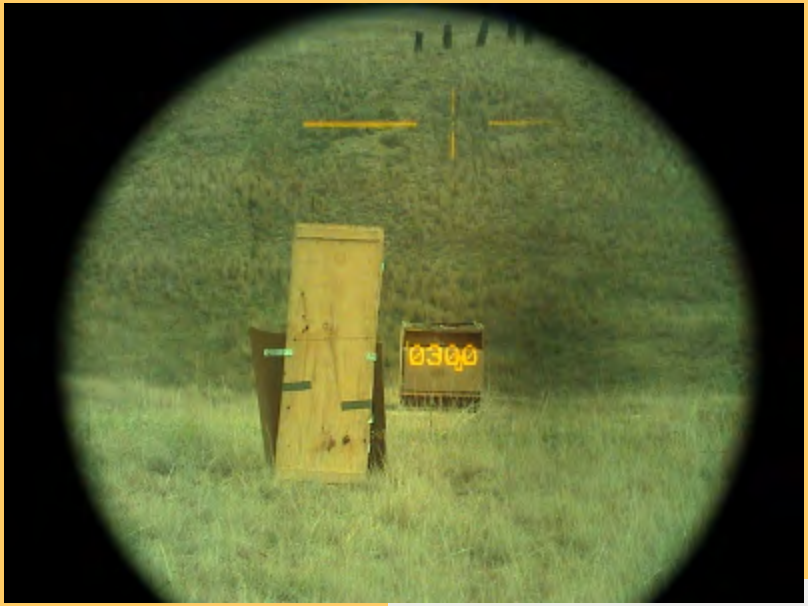
BURST-TO-BURST (B-B)

- Initial Aiming
- B-B Dispersion - Vertical
- B-B Dispersion - Horizontal
- T&E accuracy error (vertical)
- T&E accuracy error (horizontal)
- Visual Resolution
- Muz. Vel. (lot-lot)

WITHIN-BURST (W-B)

- Muzzle Velocity (within lot)
- Muzzle Velocity Correction
- W-B Weapon Dispersion - Vertical
- W-B Weapon Dispersion - Horizontal
- Ammunition Dispersion - Vertical
- Ammunition Dispersion - Horizontal
- Drag Variability
- Projectile Mass Variation
- MV Correction Algorithm
- Fuze Timing

USER Evaluation of Operational Utility



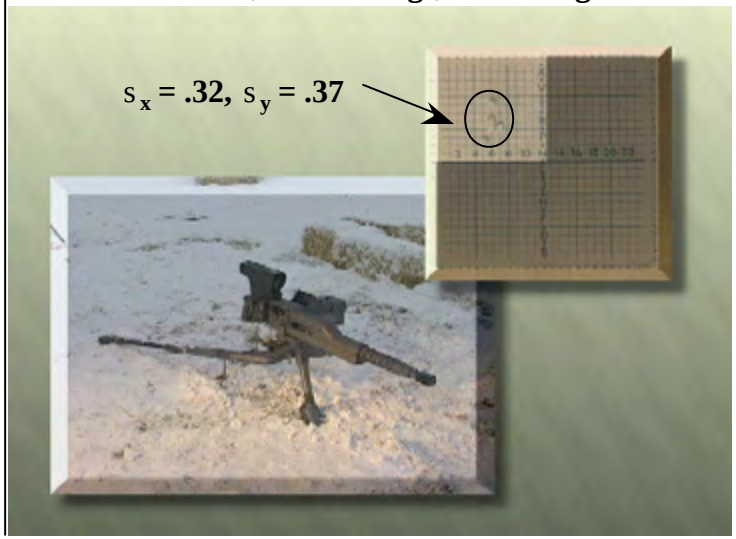




Nov 2000

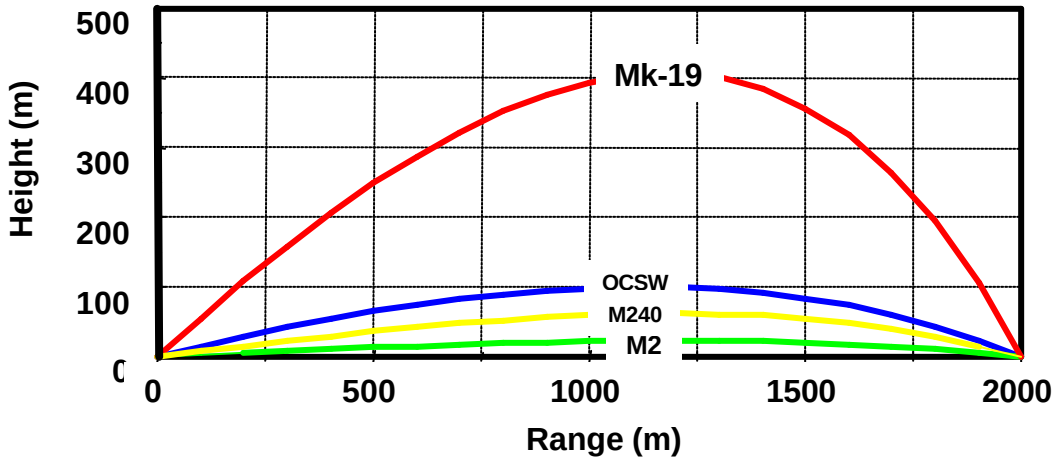
Exterior Ballistic Performance

Minimal Weapon Dispersion
s_{xave} = 0.5 mrad, s_{yave} = 0.5 mrad
5 round burst, no sandbags, 100m target

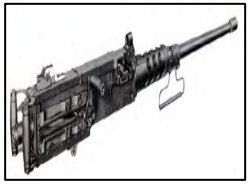


- Ammunition dispersion demonstrated at less than 0.2mils from a Mann barrel.
- Ammunition dispersion demonstrated at less than 0.4 mil from the OCSW weapon in full automatic fire.

Time of flight to 2000 meters half that of the MK19.



CREW SERVED WEAPON SYSTEMS
Heavy & Medium Machine Gun Comparisons

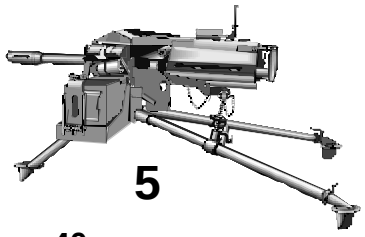
					
	MK 19 (40 mm)	**Striker (40 mm)**	**M2 (.50 Cal)**	**M240B (7.62 mm)**	**OCSW (25 mm)**
GUN	76 lbs		84 lbs	27.3 lbs	27/23 lbs
MOUNT	68 lbs	70-80 lbs (System)	44 lbs	15 lbs	11/9 lbs
FCS/Thermal	5 lbs		5 lbs	4.5 lbs	7/6 lbs
AMMO	59.5 lbs (48 rds)	59.5 lbs (48 rds)	38 lbs (100 rds)	18 lbs **(200 rds-**)**	28/28 lbs. (62rds)
TOTAL	**208.5 lbs**	**139.5 lbs**	**171 lbs**	**64.8 lbs**	**73/64 lbs Current/FUE**

OCSW Weight 60 % < M2, MK19

OCSW Defeats Defilade Targets

Logistics Comparison (Weight and Portability)

Conventional Weapons



5

40mm

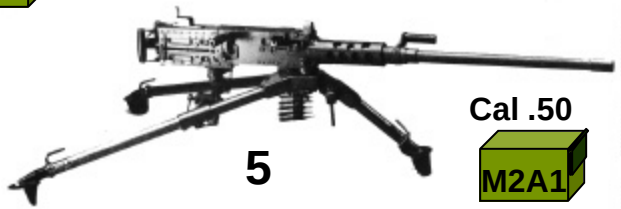
M548



18

7.62mm

M2A1



5

Cal .50

M2A1

28 Weapons

2136 Lbs

OCSW Weapon



28

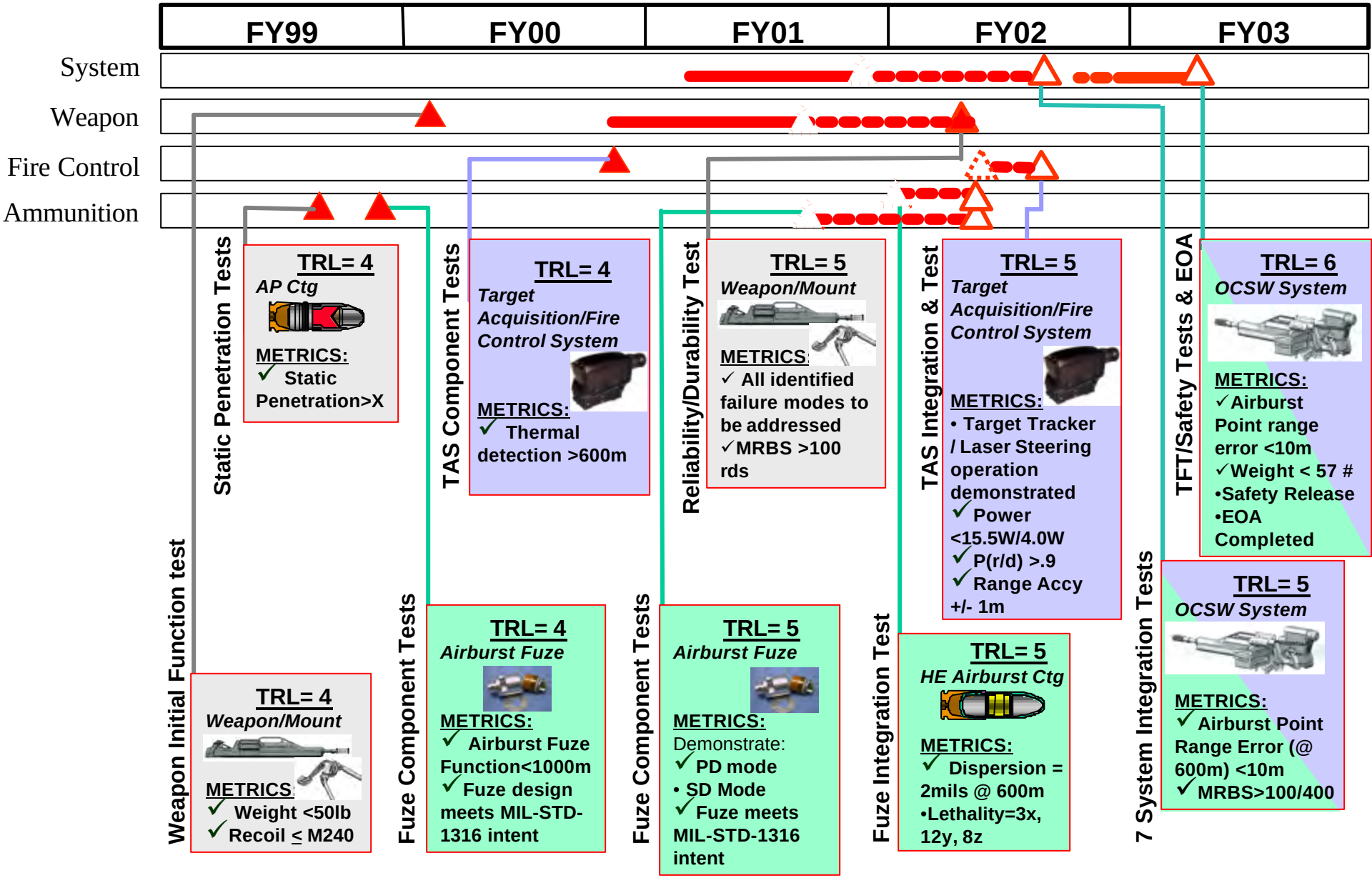
25mm

OCSW

28 Weapons

1134 Lbs

Objective Crew Served Weapon System



OCSW System Integration Summary

- 5 of the 7 System Integration Tests have demonstrated maturity growth led by General Dynamics AS group
- Remaining 2 Systems Integration Test will increase reliability and refine dynamic subsystem interaction

2002 International Infantry & Joint Services Small Arms Systems Symposium

Delivery of Non-Lethal Mortar Payloads

by Mortar Systems

Joint RDT&E Pre-Milestone A Program

14 May 2002

Matthew Evangelisti

USA TACOM-ARDEC

973-724-2851

mevange@pica.army.mil



Background

Existing Non Lethal Capability Set range-limited. In 1998, Joint Non Lethal Weapons Directorate sought industry proposals for long range non-lethal delivery systems. Two winning proposals both mortars solutions. Contracts awarded 3 years ago this month. September 2000, ARDEC asked to manage overall program

The Challenge

Non-lethal Mortar must meet a stringent Kinetic Energy Criterion: No portion of the cartridge can impact the target area with a KE greater than 58 ft-lbs. Typical mortar cartridge weighs several pounds and impact velocities exceed 300 ft/sec. Conventional design concepts won't work, positive measures must be taken to mitigate the KE before impact.

Current Status

At the present time, the IPT is evaluating the efficacy of several Terminal Kinetic Energy approaches being investigated, and starting to define the overall cartridge design. There are many issues and challenges to be met in applying mortars technology to this requirement.

We are working with the OIWC Team as they have a similar problem.

DoD Directive 3000.3, 9 Jul 96
Policy for Non-lethal Weapons (NLW)



. . . **Designates** . . . Commandant of the Marine Corps
Executive Agent for the DoD NLW Program . . .

. . . **Defines NLW** . . . "weapons that are explicitly designed and primarily employed so as to incapacitate personnel or materiel, while **minimizing** fatalities, permanent injury to personnel, and undesired damage to property and the environment."

. . . **Directs** . . . Services to participate in NLW program

Army Roles in NLW



Single Proponent for U.S. Army Non-Lethal Applications

- The U.S. Army Military Police School (USAMPS, at Fort Leonard Wood, MO) is the designated single proponent for Army Non-Lethal Applications, effective 12 Sep 00.

- USAMPS will serve as the U.S. Army Training and Doctrine Command's single voice for all developments and initiatives to field NL capabilities.

Army Roles in NLW

Project Manager for Mines, Countermine and Demolitions

- The Project Manager – Mines, Countermine and Demolitions (PM-MCD), located at Picatinny Arsenal, NJ, has program management responsibility for Army Non-Lethal Materiel programs, and establishing the Army's Non-Lethal Capability Sets.
- PM-MCD sits on NATO LG 9 on Combat Engineering.

Systems Manager for U.S. Army Non-Lethal Technology Integration

- The Tank-automotive and Armaments Command - Armament, Research, Development and Engineering Center (TACOM-ARDEC), Close Combat Armaments Center (CCAC), located at Picatinny Arsenal, NJ, has responsibility for leading coordination of Army NL Technology development.
- CCAC sits on NATO LG 3, Close Combat Infantry.

K.E. mitigation techniques

- Several K.E. mitigation techniques have been defined
  - Lightweight Composites
  - Parachutes/Parafoils
  - “Mapleseed” High Drag
  - “Brooming”
  - Frangible Case
  - Combustible Case
  - Any other mass and/or velocity reduction technique

NL Down Select Options

To Get To End State

Viable Candidates

Low Velocity

Lightweight Composites

Mass and/or velocity reduction techniques

Parafoils

Parachutes

Low Mass, Low Velocity

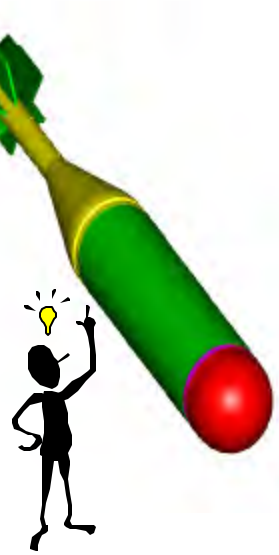
Maximum Terminal KE, 58 ft-lbs **Mitigate Kinetic Energy**

"Mapleseed" High Drag

Combustible case technologies

Frangible Case

Low Mass



NL Mortar Munition

Milestone *A*

Key objective: mitigate Terminal Kinetic Energy

A major challenge will be to come up with a cartridge that can meet all applicable weapon Requirements without exceeding non-lethal Kinetic Energy Criteria. All approaches, weight reduction, combustible cartridge, velocity mitigation, etc will be explored.

Requirements

MS A Exit Criteria

Criterion	Threshold	Goal
• Cartridge Size	81mm	60 – 120mm (Scaleable)
• Range	200-2500m	200-5100m
• Maximum Terminal KE	58 ft-lbs	25 ft-lbs
• Payloads	Liquid, Aerosol, Powder, Solid	Same
• Area Coverage	Type of Payload Dependent	25m ² min
• Delivery Accuracy	One PE*<15M up to 1500m	One PE*<15m up to 1500m & <1% beyond 1500m

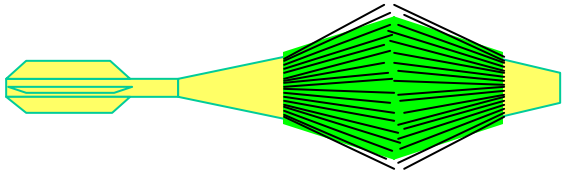
* PE= Probable Error

M2 Technologies, Inc.

M2 Mass Mitigation Approaches

Brooming Composite Casing Concept

- *Filament Wound or Pultruded Shell*

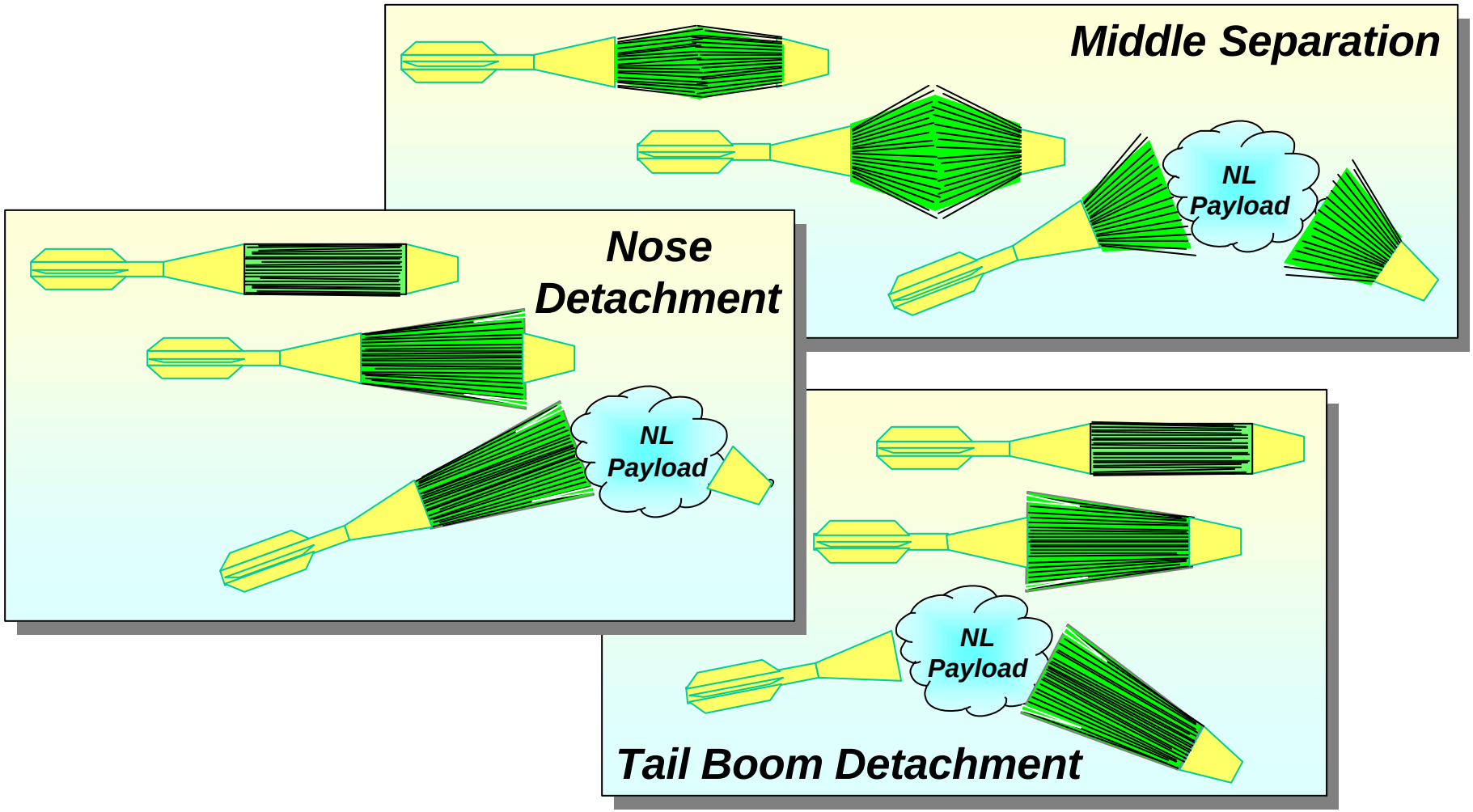


- *Low Cost GL/Polymer Materials*
- *Stress Induced Matrix Disruption and Resulting Fiber Brooming*
- *Casing breakup initiated via gas generator*
- *Solid, Liquid, Powder Payload Flexibility*
  - *- Bladder*
  - *- Sleeve*

This document contains information that is proprietary

M2 Mass Mitigation Approaches

Brooming Concept Execution Options



This document contains information that is proprietary

M2 Mass Mitigation Approaches

45 Degree S-Glass Cylinder Burst Test Specimen



This document contains information that is proprietary

United Defense

Mapleseed

Rotor Deployment Sequence







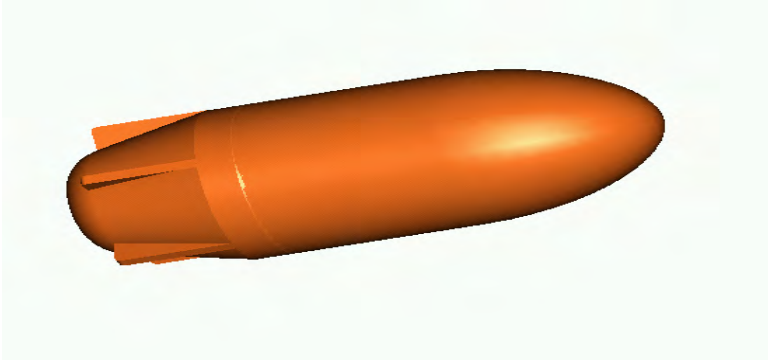


- Testing of the mapleseed scheme to optimize its drag and/or lift.
- UDLP began investigation of cost effective ways to fabricate the composite bodies and nosecones.

This document contains information that is proprietary

ARMTEC work :

- Develop a method for successful launch of NL payload carrier from 120mm mortar system. High angle of fire weapon system optimal for MOUT Operations.



- Establish payload capability for this system.
- Establish the circular error of probability (CEP) for payload.
- Work with ARDEC in follow-on development of payload and deployment system.

Proprietary Data Statement

This document contains information that is proprietary to Armtec Defense Products Company. This information shall not be duplicated, used, or disclosed in whole or in part for any purpose without the express written consent of Armtec Defense Products Company.

Velocity Mitigation

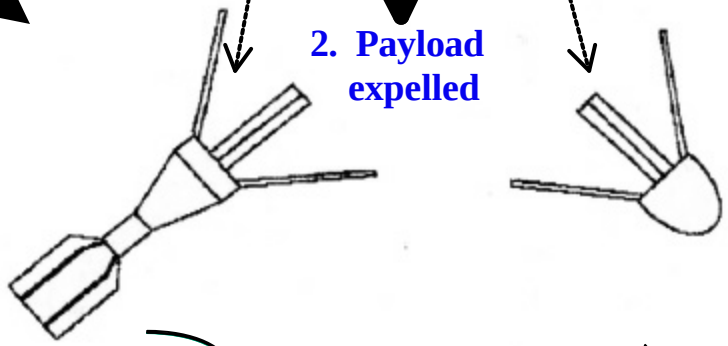
In House NL Mortar Concepts

Double Vane Decelerator *

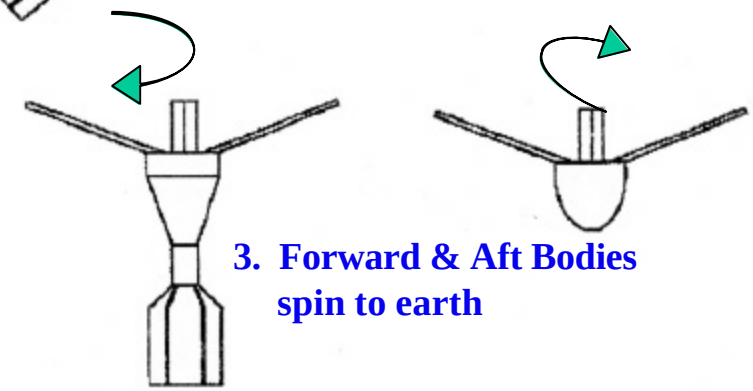
OPERATIONAL SEQUENCE



1. Munition divides into forward and aft



2. Payload expelled



3. Forward & Aft Bodies spin to earth



8 Interlocking Vanes form centerbody

Interlocking Vane



*Patent pending

Upcoming Associated Activities

Jan 02 – Feb 02	Testing of In-House Design	Picatinny & Wright Paterson
May 6	phase II	"

In House NL Mortar Concepts



In House NL Mortar Concepts





TACOM-ARDEC



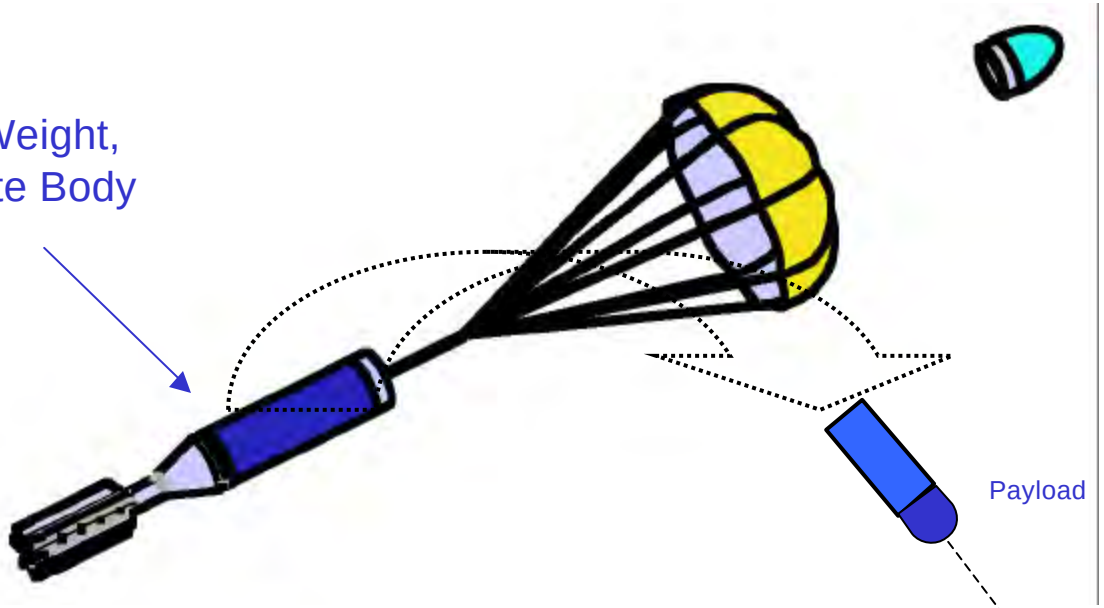
Single Parachute-Lightweight Composite

TACOM-ARDEC

In House NL Mortar Concepts

Fuze in rear

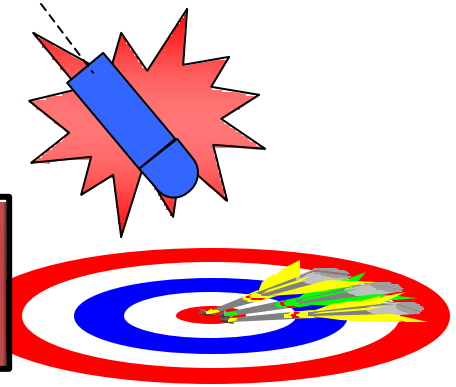
Light Weight,
Composite Body





Lightweight (composite) Vehicle with 2 Parachute Delivery





Program Status

- Pre-Milestone A Program
- Bench Tests, Static Firings, Wind Tunnel Testing ongoing
- Milestone A Scheduled for 3QFY03
- Demo Firings 2QFY03: TRL 4



MOUT ACTD Breaching

Mr. Adam Fields

MOUT ACTD Senior Engineer (SETA Contractor)

US Army Soldier and Biological Chemical Command

Natick Soldier Center

(508) 233-4265

Email: adam.fields@natick.army.mil



Agenda

- MOUT ACTD Overview
- MOUT ACTD Requirements
- COTS Technology Solutions
- Operational Lessons Learned
- MOUT ACTD FY01 Extension
- Future Work

Background
MOUT ACTD Mission

Improve the operational capabilities of Soldiers and Marines in MOUT

- **Evaluate advanced technologies to provide technological dominance in MOUT, including TTPs to employ new capabilities.**

- **Provide interim capabilities to operational units with TTPs.**

- **Set the stage for rapid acquisition of selected technologies.**



MOUT ACTD Breaching

- Requirement 30 - Door Breaching
  - non-explosive
  - quick and quiet

- Requirement 27 - Wall Breaching
  - small, fast, simple
  - man-sized hole in concrete walls
  - average soldier/Marine (not Engineers)

R30A – DOOR BREACHING, MECHANICAL

- Halligan Tools
  - Large and bulky
- Door Jamb Spreaders
  - Hydraulic rams
  - Not robust enough

- **RESIDUAL: DEMTEX Breaching Kit**
  - Halligan tool
  - Bolt Cutters
  - Mini-sledge



R27 – WALL BREACHING (1)

- Two COTS products
  - Explosive Cutting Tape (ECT) - EBCo
  - BEAST – H.E.A.T.
- Pre-packaged explosive charge
- Hand emplaced





R27 - ECT Video



R27 – WALL BREACHING (2)



- Brick targets
  - Creates man-sized hole
- Concrete targets
  - Creates man-sized hole
  - Rebar grid still intact
  - ***Requires Secondary action to cut remaining rebar grid***

- TRANSITION: ARMY FY03 SEP
  - Infantryman's Wall Breaching Kit

Wall Breaching System Employment

- (+) Enables soldiers to quickly create a breach wherever they need
- (+) Uses standard and commercial initiation systems
- (+) Soldiers/Marines can be quickly trained
  - Reduces need for Engineers – rifle platoon more capable
  - Soldiers must use only for tasks in which they are trained
- (-) These items are both hand emplaced
  - increases exposure time in “kill zone”
  - follow-on rebar cutting operations increase this exposure time even further
  - Soldiers-in-the-street can be on a level playing field with enemy forces – minimizes US technology advantage

STANDOFF BREACHING

- Soldier/Marine can create a mobility corridor wherever one is needed
- Troops rapidly enter structure – maintain element of surprise
- Technology advantage AND training advantage indoors
  - night vision
  - room clearing



R30B – DOOR BREACHING, STAND-OFF EXPLOSIVE

- Rafael Simon Round – declassified Israeli Defense Forces technology
- Rifle launched using high power blank round



- But…R30 Requirement was for “non-explosive” breaching
- Standoff explosive breaching acts extremely quickly – maintain the element of surprise

- Additional benefit – personnel and booby traps are incapacitated
- Product for window breaching – 1/3 explosive charge

R30B - Simon Video



TRANSITION: RLEM Program

- Simon recommended for the US Army Warfighter Rapid Acquisition Program
- Proponent CG, USAIC
- Approved as Rifle Launched Entry Munition (RLEM) Program
- Requirement for bullet trap activation for operational use, blank round activation for training purposes
- Recoil reduced to meet US Army requirements

WALL BREACHING, STAND-OFF

- Explosively Formed Penetrators (EFPs)
  - examined early in program as a possible means to breach concrete walls and rebar
  - EFPs require large amounts of explosive to propel them to the target

- .50 cal Frangible Ammunition
  - White paper funded to examine feasibility
  - M&S show projectiles can breach concrete and rebar
  - Precision required and quantity of ammo needed restrictive

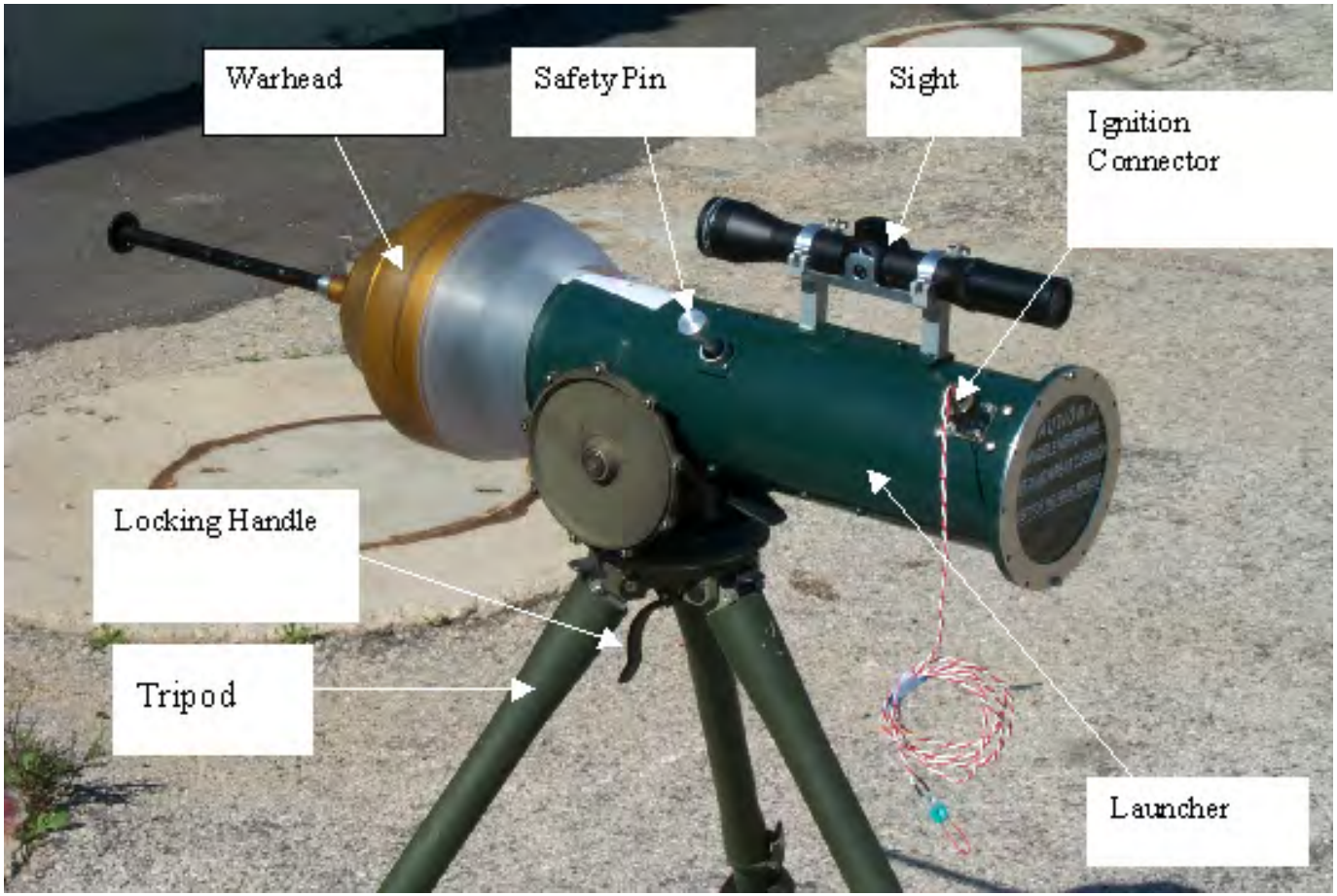
MOUT ACTD EXTENSION

- MOUT ACTD approved for FY01 Technology Extension
- Team able to invest in technology development (vice COTS/GOTS)



- MOUT ACTD funded development of the Wall Breaching Standoff Munition (WBSM)
  - Leverages Simon technology
  - tripod mounted, rocket launched system
  - breaches man-sized hole in double- or triple-layered brick wall
  - Effective range of the WBSM is 15m to 40m

WBSM System Components



FUTURE WORK

- Submitted FY04 UFR to continue development of the warhead – to enable defeat of reinforced concrete
- Requirement has been validated and funding needs to be identified
- Will use Rafael patented “Explosive Formed Ring” technology
- WBSM munition to be
  - compatible with US-utilized shoulder launch platforms
  - able to be fired from confined spaces

- USMC/MCWL program called “Wall Breaching round for the SMAW”
  - Difference in stand-off distance





MOUT ACTD Breaching

Mr. Adam Fields

MOUT ACTD Senior Engineer (SETA Contractor)

US Army Soldier and Biological Chemical Command

Natick Soldier Center

(508) 233-4265

Email: adam.fields@natick.army.mil



IDIA 2002 International Infantry & Joint Services Small Arms Systems
lection Symposium, Atlantic City, NJ - May 13-16, 2002

OERLIKON CONTRAVES

30mm x 173 Ammunition Family

Allan Buckley* & Pierre H. Freymond
Oerlikon Contraves Pyrotec AG
CH-8050 Zurich / Switzerland
ocp-marketing@ocag.ch

 P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

OERLIKON CONTRAVES

hreat Spectrum














P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

OERLIKON CONTRAVES

0 mm x 173 Ammunition Family

APFSDS-T



FAPIDS-T



TPFDS-T



ABM



Notice: SAPHEI-T, TP-T and TP rounds also available

P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

Major Technologies Involved

Subcaliber: Tungsten Material (Long Rod, Frangible)

Sabot (Plastic Injection Molding)

Full Spin Firing (Long Rod)

ABM: Programmable Fuze

Payload (W-Subprojectile)

P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

ubcaliber Technology:
abot Discarding at Full Spin

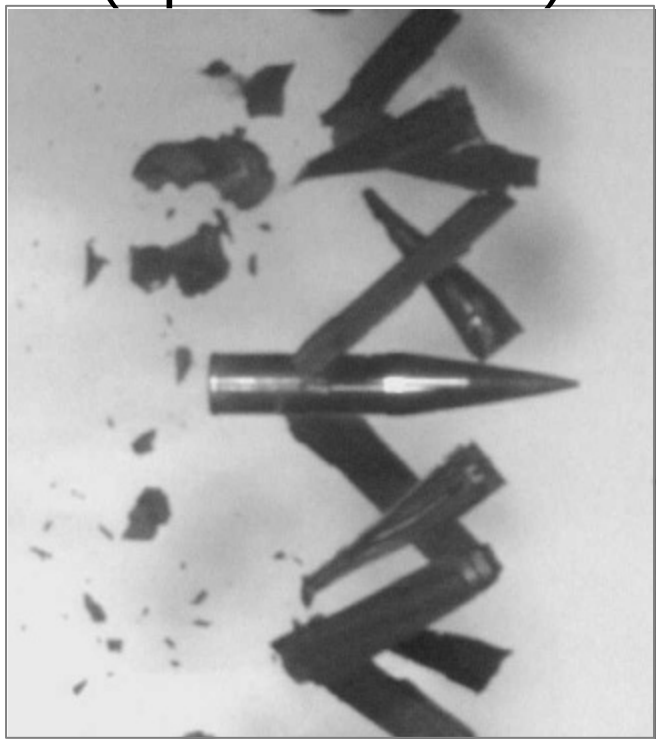


Long Rod
(Fin Stabilized)





Frangible
(Spin Stabilized)



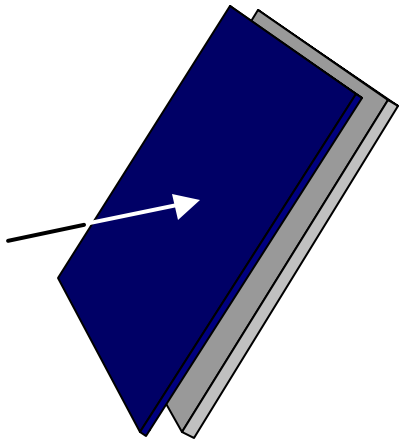
P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

0mm x 173 Long Rod (APFSDS-T)
fficacy on Armoured Vehicle APC/IFV

OERLIKON CONTRAVES

Spaced Armour:
15 mm HHA
30 mm RHA

Obliquity: 45°
Range: 2 km

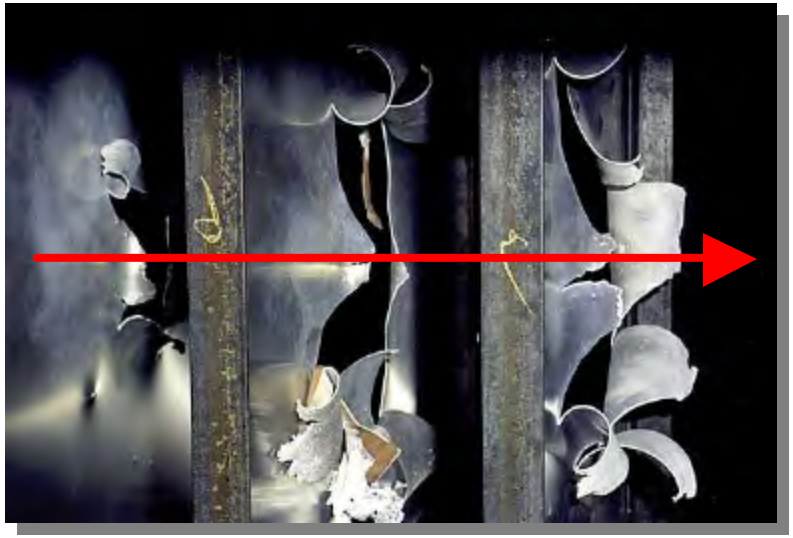


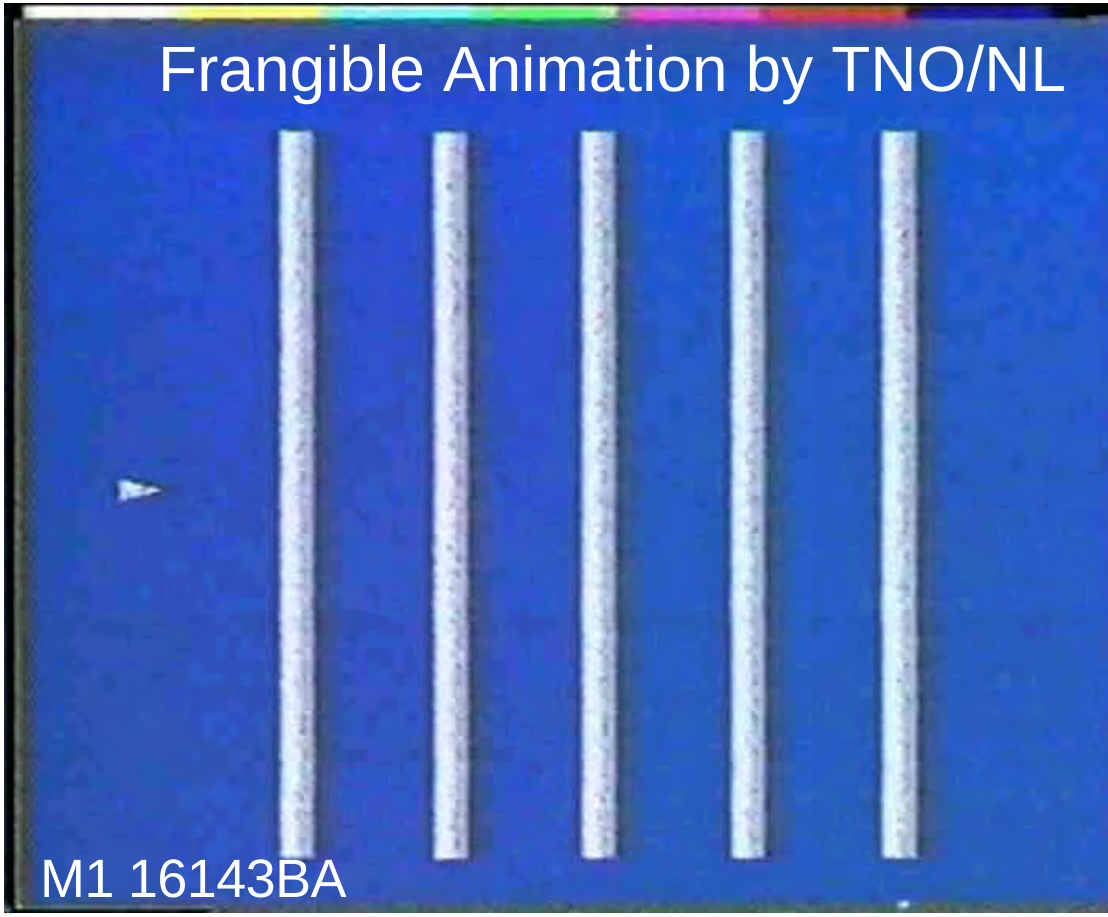


OERLIKON CONTRAVES

rangible Effect







APDS Ammunition
ffectiveness against Helicopter

OERLIKON CONTRAVES

Firing Video



Target after Firing

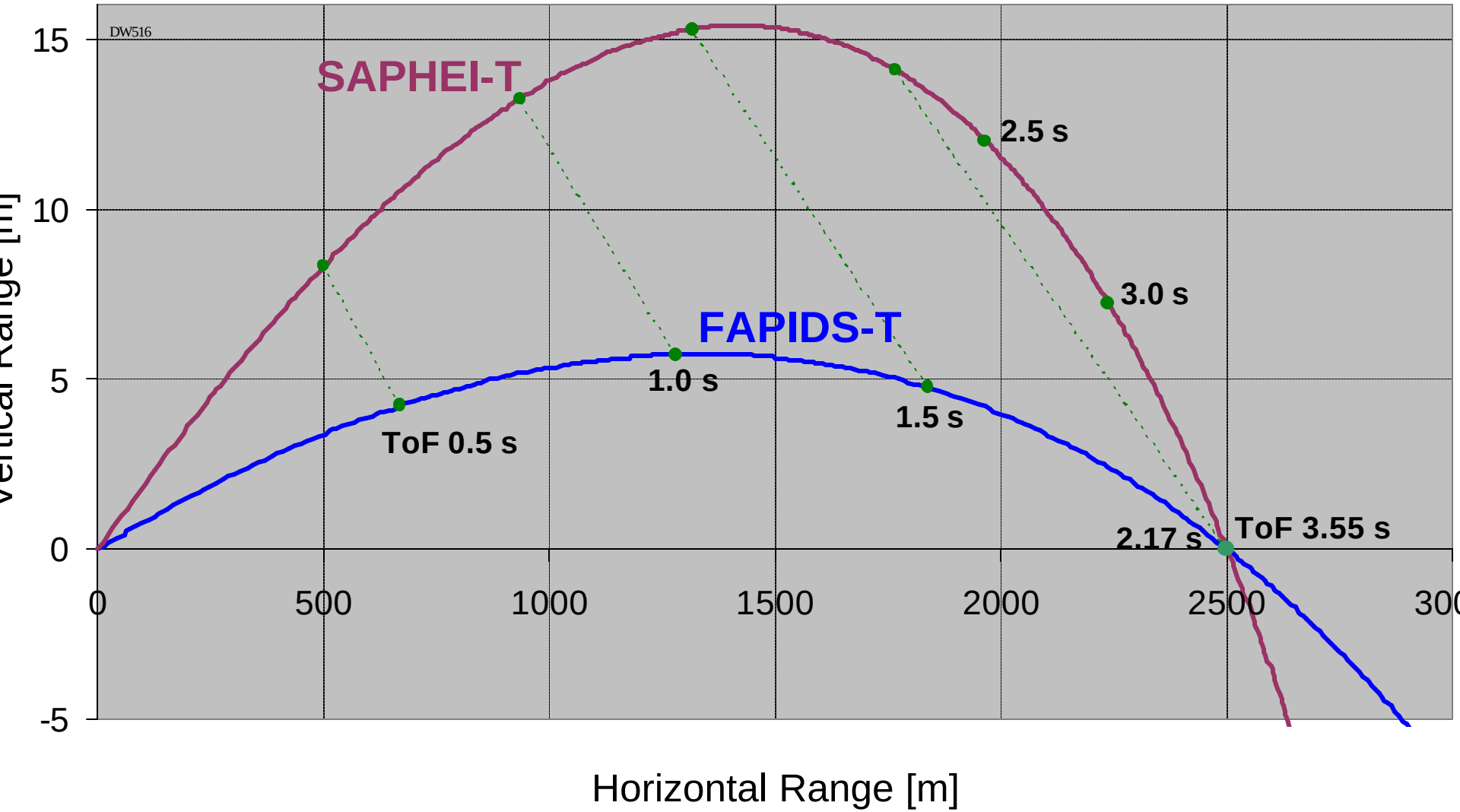


3 Round Burst at 1200 m Range

P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

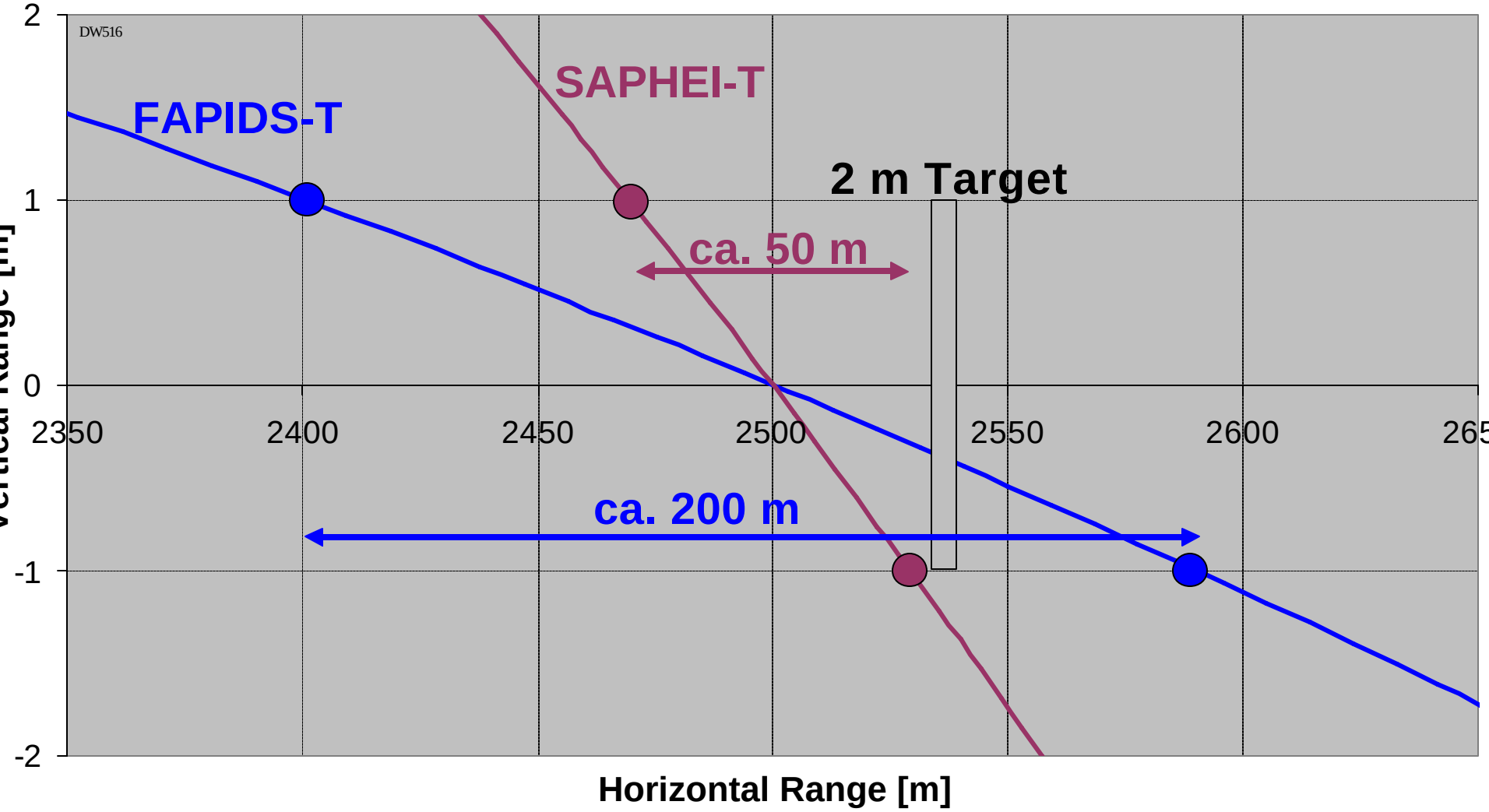
0mm x 173 Ammunition
rajectory Comparison

OERLIKON CONTRAVES



P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

0mm x 173 Ammunition
ight Range Comparison at 2.5 km Range

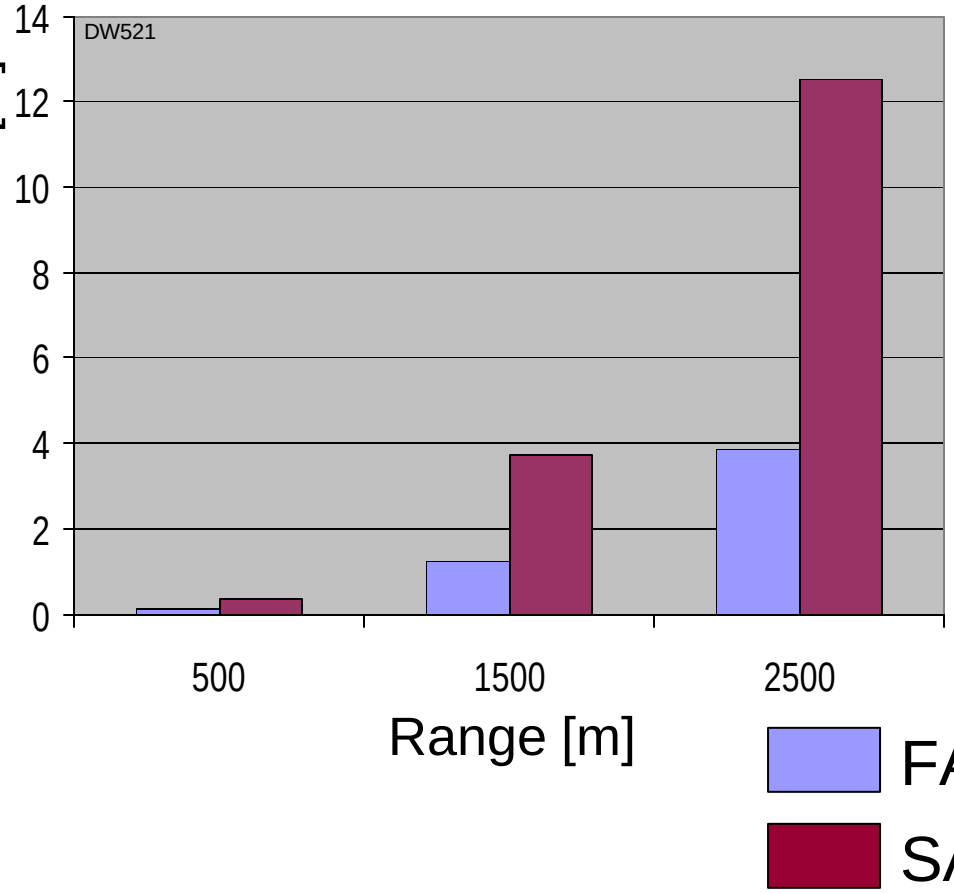


P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

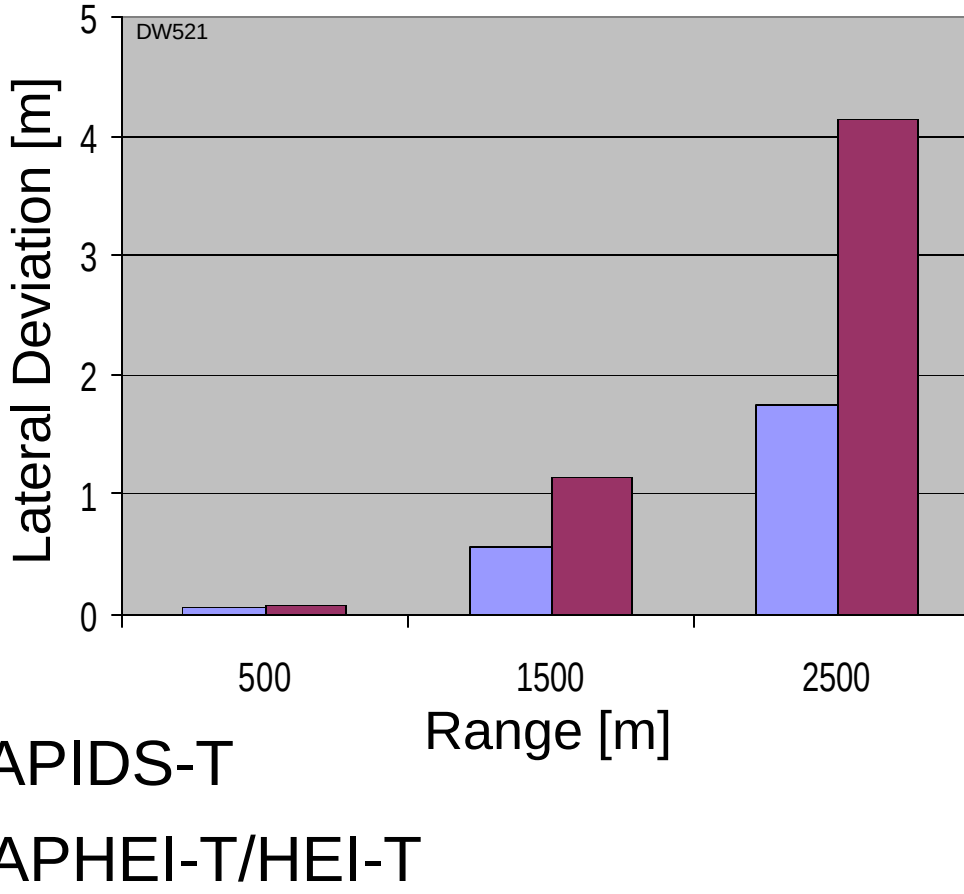
0mm x 173 Ammunition
arameter Influence on Ballistics

OERLIKON CONTRAVES

10m/s Cross Wind



5° Side Tilt of Gun Mount

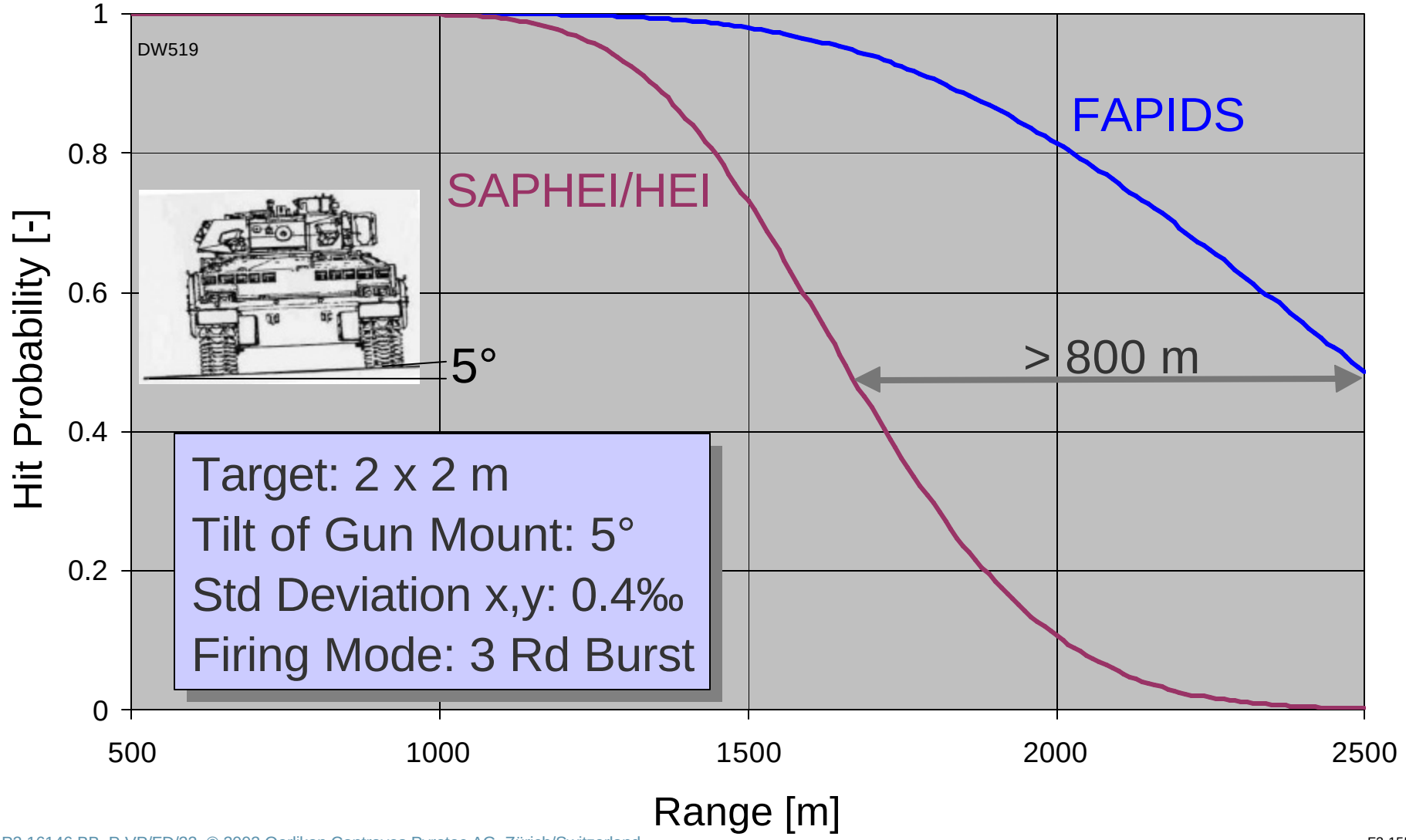


FAPIDS-T

SAPHEI-T/HEI-T

P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

0mm x 173 FAPIDS vs SAPHEI/HEI
lit Probability vs Range



 P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

mmo 25 mm x 137: Effectiveness
omparison against Urban Target

OERLIKON CONTRAVES



HEI-T





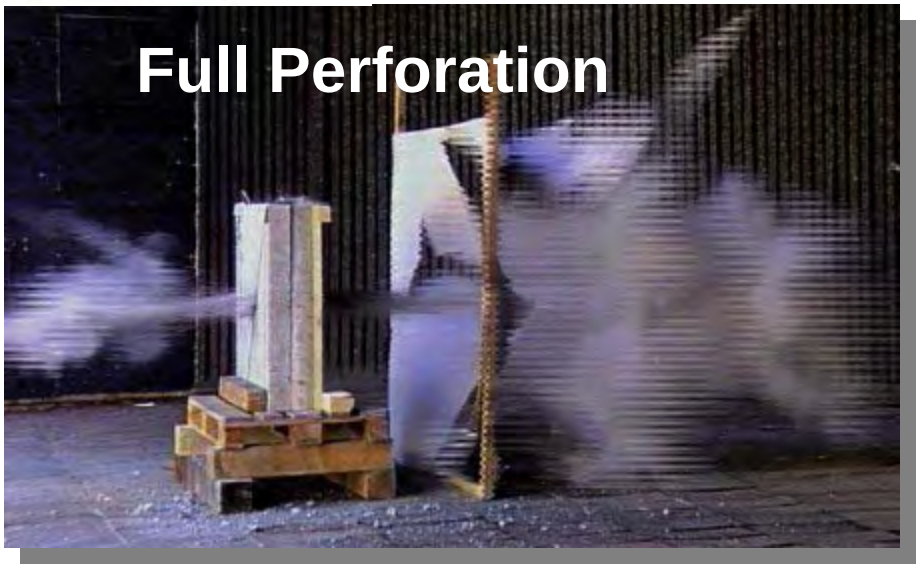
SAPHEI-T



Target: 20 cm (2 x 10 cm) Concrete Wall with double steel-structure reinforcement at a range of 1500 m

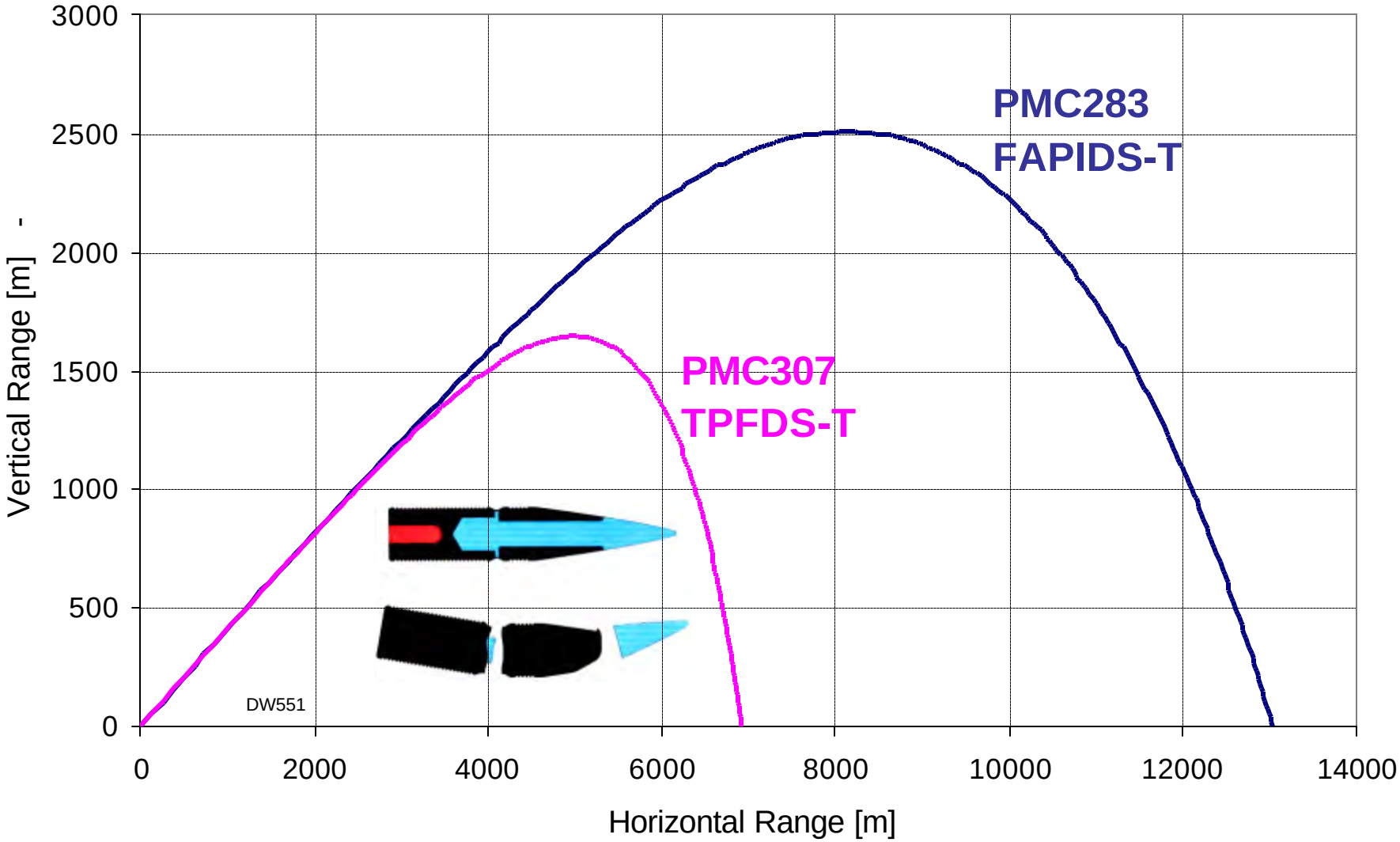


FAPDS-T



 P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

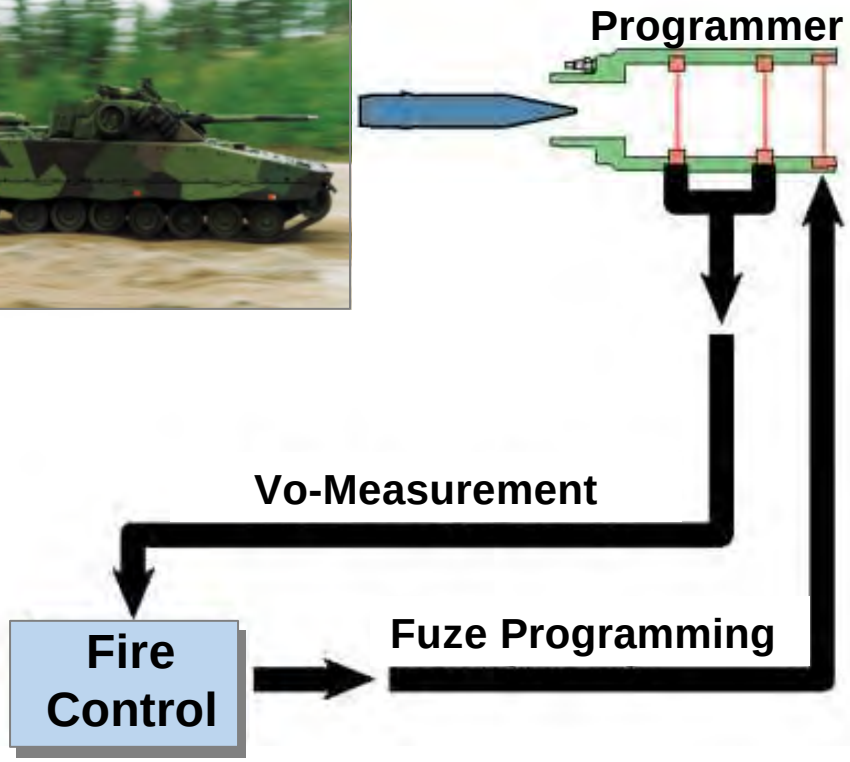
allistic Comparison
raining TPFDS-T vs Frangible FAPIDS-T Rd

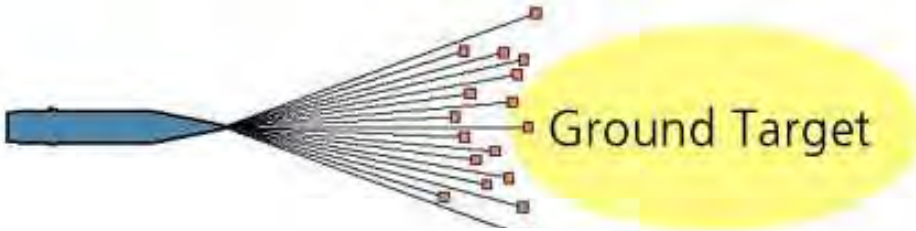


ir Bursting Munition Technology

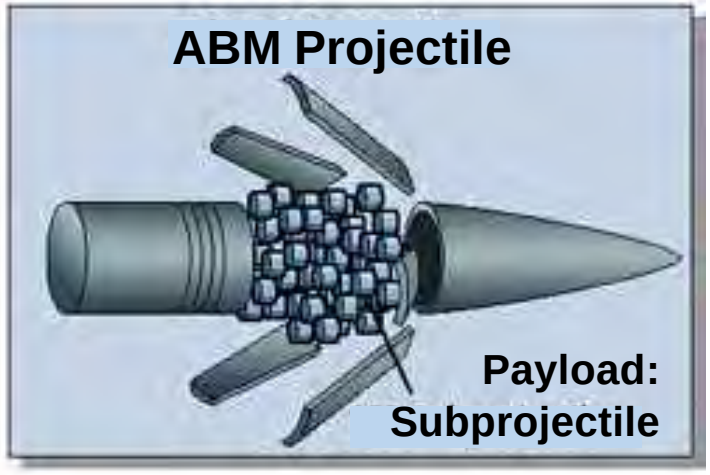
BM for Infantry Vehicles







Payload Ejection



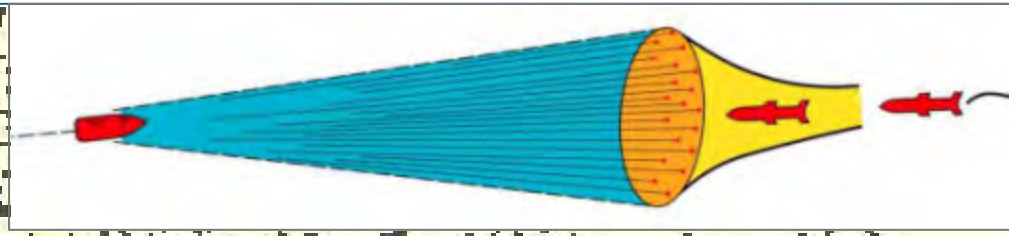
P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

OERLIKON CONTRAVES

Air Bursting Munition Performances



Aircraft





Missiles



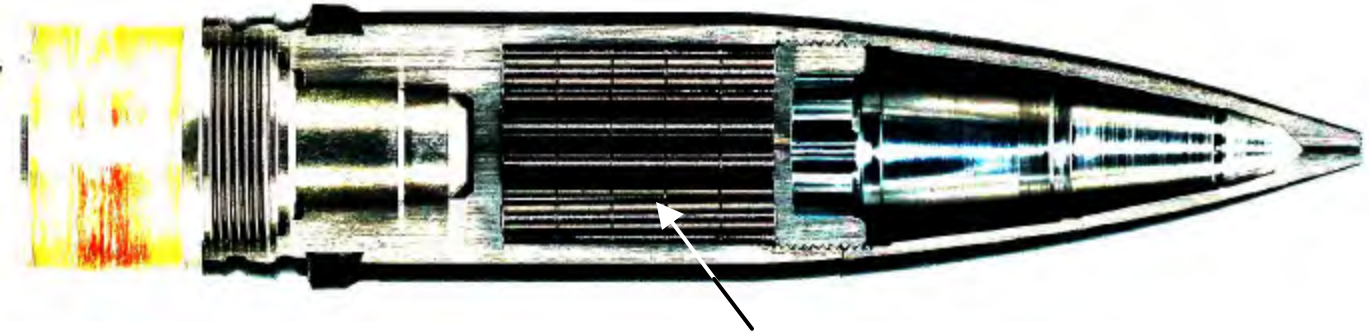
Soft Targets



Tanks

P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

One ABM Fuze System (Ahead) - Two Different Warhead Systems



30mm x 173

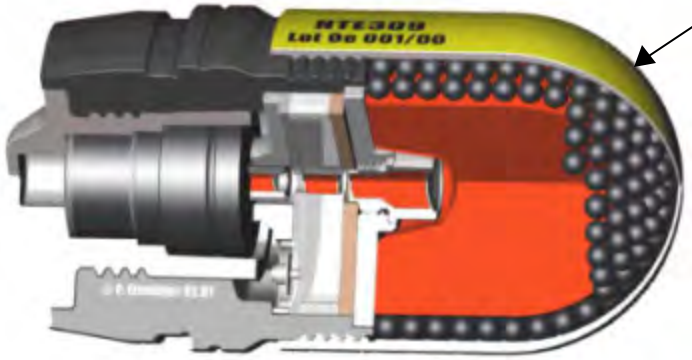
(35mm x 228)

Subprojectile Warhead
(KETF: Kinetic Energy Time Fuze)



Fuze

Blast Fragmentation Warhead
(HETF: High Explosive Time Fuze)



Scale:

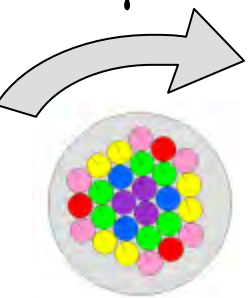


40mm x 53

30 mm ABM Subprojectile Payload Ejection Dynamics

35 Subprojectiles at 1.5 g
approx. 200 g Payload

0 µs

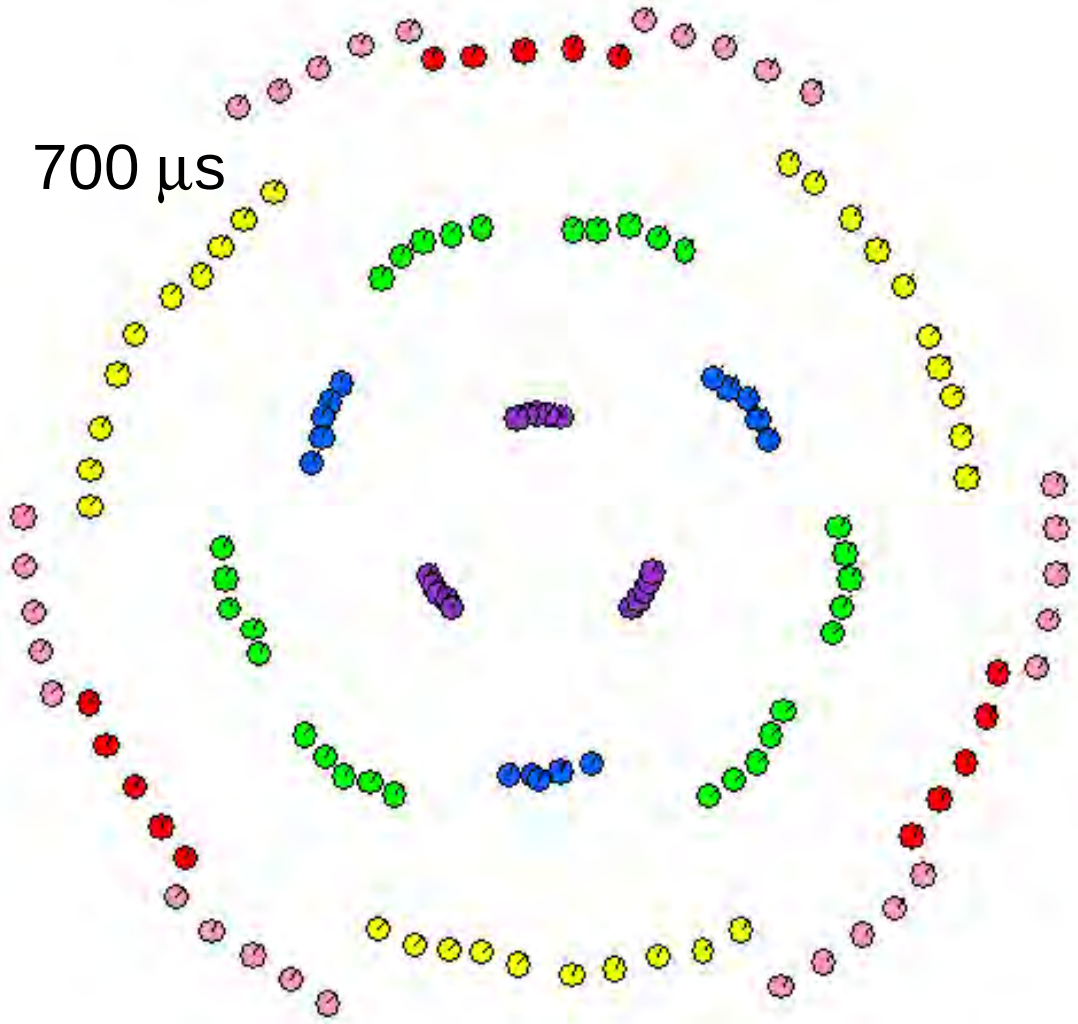


125 µs



27 x 5 Layers

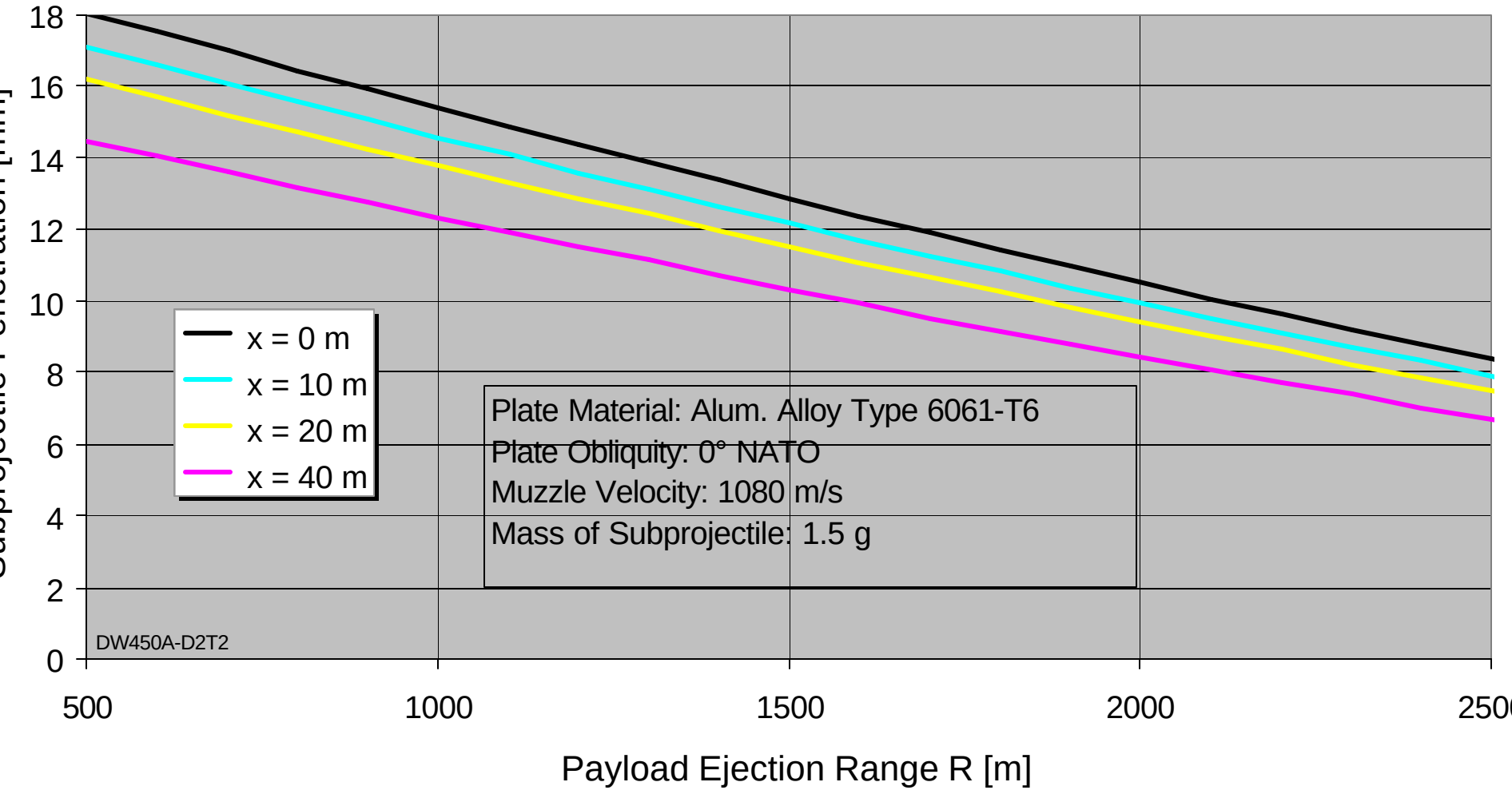
700 µs



OERLIKON CONTRAVES

ABM Subprojectile Penetration

Parameters: Subprojectile Ejection Range R & Ejection Distance x



P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

BM 30 mm x 173
ffectiveness against ATGW-Bunker at 1 km

OERLIKON CONTRAVES











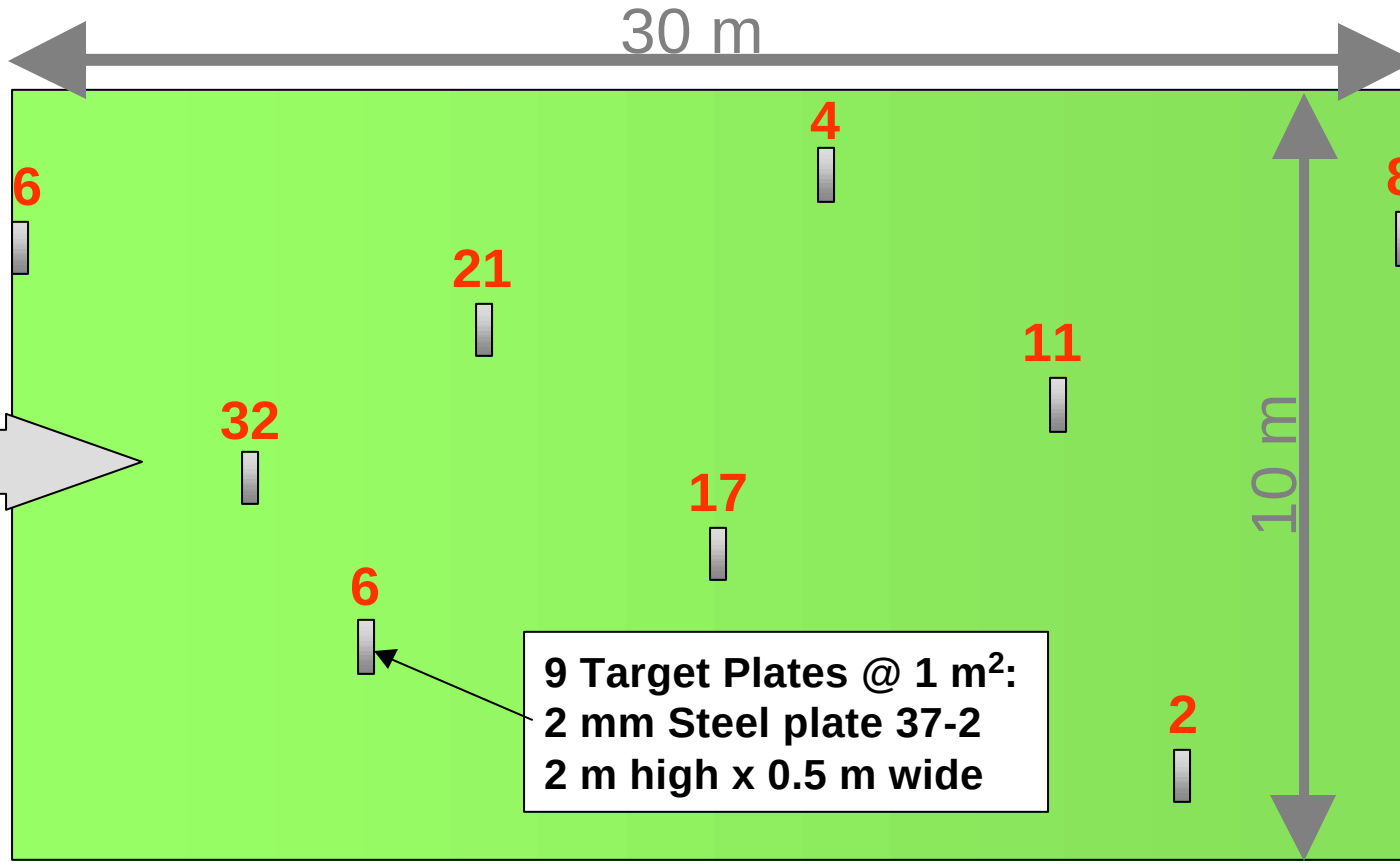
P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

ABM KETF 30mm x 173 against Squad of 9 at 1.2 km Range



4 Rds @ 135 Subprojectiles = 540 SP

Total: 107 Plate Perforations (~ 20%)

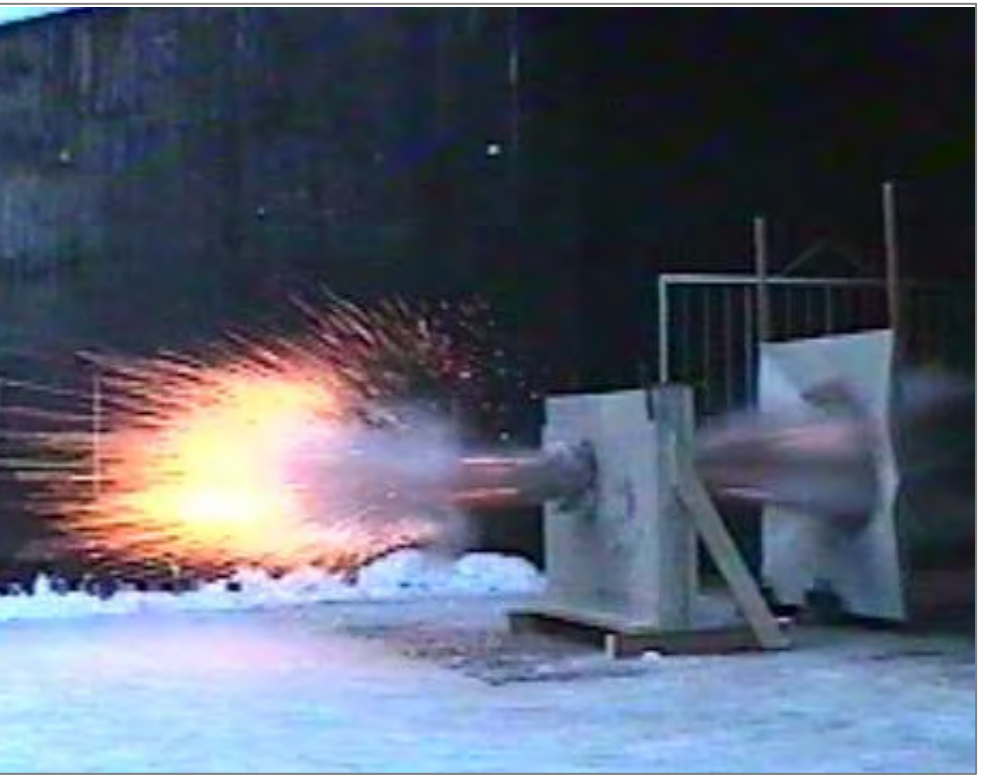


P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

BM KETF 30mm x 173 against Urban Target (Unprogrammed Fuze)

OERLIKON CONTRAVES

arget: 20 cm Concrete Wall with double Steel-Structure Reinforced
esults: Target Fully Penetrated





 P2 16146 BB, P-VP/FD/22, © 2002 Oerlikon Contraves Pyrotec AG, Zürich/Switzerland

U.S.AIR FORCE

Air Force

DEFENSOR FORTIS



USAF

Lt Col Jorge Garza
HQ Air Force Security Forces Center
“Combat Arms Center of Excellence”
Lackland AFB, TX
DSN 473-1206 Commercial (210) 671-1206

NEW MISSION/TECHNOLOGIES

- **Air Force Frangible Munitions**
  - Only cost effective solution to environmental problems
    - Eliminates environmental, health, and most safety problems
    - Executive Order 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements do not exempt US Military services
  - Frangible currently approved for 9mm and 5.56mm only
    - Limited to training use only
    - Accuracy at 25 meters is indistinguishable between lead based and frangible
  - Air Force is currently interested in 12 gauge and 7.62mm frangible for use at 10 meter targets and increased accuracy at greater distances

AREAS OF INTEREST

- Counter stand-off weapons and enemy forces in all weather conditions during day or night
- See around corners and out of defilade positions without exposure to enemy fire
- Rapidly locate, in real time, the origin of sniper/indirect enemy fire and counter this threat
- Engage enemy targets with improved accuracy, lethality, and at increased ranges with individual and crew served weapons
- Discriminate between friendly, enemy, and noncombatant personnel, in real time
- Directed energy weapons for non-lethal missions, such as laser, acoustic, pulse, microwave, etc

TACOM

Lethality, Survivability, Mobility and Sustainment for America's Army

JSSAPMC UPDATE

2002 NDIA INTERNATIONAL INFANTRY

AND

JOINT SERVICES SMALL ARMS SYMPOSIUM

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COL Michael Padgett, Commander CCAC
Chairman JSSAP MC
Phone: 973-724-7940
Email: mpadgett@pica.army.mil

JSSAPMC MISSION

- Harmonize and Execute Joint RDT&E Projects
- Identify and Apply Technology Base
- Establish Joint Requirements
- Transition to PM's for SDD and Production
- Continue Development and Production Oversight
- Serve as Focal Point for Alliance Needs and Development

JSSAPMC MEMBERSHIP

Chairman

COL Michael Padgett (Commander, CCAC)

Army:	Mr. F. Stone (USAIC)
Marines:	Mr. D. Hansen (MCSC)
Air Force:	LtCol J. Garza (HQ AFSF)
Navy:	Mr. J. Gaskill (NAVSEASYSCOM)
Coast Guard:	CAPT D. Deputy (HQ USCG)
SOCOM:	COL T. Spellissy (HQ SOCOM)
Army PMSW	LTC G. Z. Brown (PEO SOLDIER)
JNLWD:	Mr. K. Swenson (JNLWD)

JOINT SERVICE SMALL ARMS MASTER PLAN (JSSAMP)

- DoD Small Arms RDT&E Guide
- Small Arms Development and Fielding Strategy
- Key Fiscal Planning Document
- Congressionally Approved, June 1995
- 2nd Edition, 5 October 1998 MG Cosumano, Assist. DCSOPS, Force Development
- 3rd Edition draft in final review



Committed To Excellence

JOINT SERVICE SMALL ARMS ROADMAP

PRESENT	EMERGING	FUTURE
M4	MODULAR WEAPON (M4/M16A2)	OBJECTIVE INDIVIDUAL COMBAT WEAPON
M16A2		
M203		
M249	Advanced Medium Machine Gun	
M60	M240B	OBJECTIVE CREW SERVED WEAPON
M2		
MK19		
M24		OBJECTIVE SNIPER WEAPON
M9		OBJECTIVE PERSONAL WEAPON
		JOINT COMBAT SHOTGUN



















Objective Force

Light Fighter Lethality

Committed To Excellence

JSSAPMC PROCEEDINGS

- **Semi-Annual Meetings**
  - Service Needs Interchanges
  - Approve Annual Program (STO/ATD)
  - Requirements, Technical and Acquisition Interchanges
  - Conducted Non-Lethal Joint Shotgun Ammo Feasibility Tests.
- **Address Individual Service Needs**
  - Arranged USMC to USAF transfer of M16A2's and M9's.
  - Arranged USMC to Navy transfer of coded M60's.
  - Delivered Army/USMC M4 Training Materials to USAF.
  - Delivered Survey of Green 9mm Frangible Ammo to USCG.

EME

NATIONAL SMALL ARMS CENTER

PRESENTED TO

NDIA 2002 INTERNATIONAL INFANTRY AND JOINT SERVICES SMALL ARMS SECTION SYMPOSIUM

ON

MAY 15, 2002

BY

DAROLD L. GRIFFIN

ENGINEERING AND MANAGEMENT EXECUTIVES INC.

ALEXANDRIA, VA 22504

OUTLINE

- **PURPOSE**
- **BACKGROUND**
- **SCOPE**
- **METHOD OF OPERATION**
- **KEY AREAS OF INTEREST**
- **PAYOFF**
- **SCHEDULE**

PURPOSE

- **PRESENT OVERVIEW OF THE ARMY'S NATIONAL SMALL ARMS CENTER**
- **CENTER WILL SERVE:**
  - **US ARMY, NAVY, AIR FORCE AND MARINE CORPS**
  - **ACADEMIA**
  - **INDUSTRY**
- **WORLD CLASS CENTER ENGAGED IN TECHNOLOGY RESEARCH AND DEVELOPMENT, TECHNOLOGY TANSFER, AND AS AN INFORMATION RESOURCE**

BACKGROUND

- **US SMALL ARMS TECHNOLOGY AND INDUSTRIAL BASE ARE THREATENED BY:**
  - **CHANGING NATIONAL PRIORTIES**
  - **DOWNSIZING AND RESTRUCTURING OF INDUSTRY AND GOVERNMENT**
  - **LOST VOICE IN DEFENSE BUDGET AND OTHER COUNSELS**

- **A STRONG PARTNERSHIP WITH ACADEMIA AND INDUSTRY WILL:**
  - **ADVANCE SMALL ARMS TECHNOLOGY NEEDS**
  - **HELP RETAIN THE US TECHNOLOGY BASE AND, IN TURN, SPUR INDUSTRY PRODUCTION**
  - **PROJECT A UNIFIED VOICE FOR SMALL ARMS COMMUNITY**

- **CENTERS ARE AN INTEGRAL PART OF THE ARMY'S TECHNOLOGY AND INDUSTRIAL BASE STRATEGY**

RATIONALE AND CONCEPT FOR CENTER

- **CONDUCTED STUDY OVER PAST SIX MONTHS**
- **LOOKED AT HISTORY OF SMALL ARMS TECHNOLOGY AND INDUSTRIAL BASE**
  - **DECLINING FUNDING AND RECOGNITION**
  - **NEED FOR A TURN-AROUND MECHANISM**
- **STUDIED NEARLY 50 ON-GOING CENTERS**
- **RECOMMENDED A SUSTAINING CENTER**
  - **LOCATED AT TACOM - ARDEC**
  - **INDUSTRY AND ACADEMIA CONSORTIUM**
  - **LONG TERM CONTRACTUAL ARRANGEMENT**

NATIONAL SMALL ARMS CENTER
SCOPE OF ACTIVITIES

- **LIFE CYCLE SCIENCE AND ENGINEERING**
- **PROGRAMMATIC AREAS**
  - **RESEARCH**
  - **TECHNOLOGY DEVELOPMENT**
  - **PRODUCT AND PROCESS DEVELOPMENT**
  - **PRODUCT AND PROCESS IMPROVEMENTS**
  - **PRODUCTION ENGINEERING**
  - **MAINTENANCE ENGINEERING**
  - **TEST AND DEMILITARIZATION**

NATIONAL SMALL ARMS CENTER
SCOPE OF ACTIVITIES (CONT'D)

- **CORE END ITEMS**
  - **HAND GUNS, SHOULDER FIRED WEAPONS, GRENADE LAUNCHERS, MACHINE GUNS, GRENADE MACHINE GUNS, AUTOMATIC CANNON AND OTHER GROUND WEAPONS / DEVICES (SUCH AS LIGHT WEIGHT ACOUSTIC AND DIRECTED ENERGY WEAPONS)**
  - **SMALL ARMS AMMUNITION OF ALL TYPES**
  - **HAND, GUN LAUNCHED AND ROCKET GRENADES**
  - **FIRE CONTROL, EMBEDDED COMPUTERS AND POWER SUPPLIES**
  - **GUN MOUNTS**
  - **FUZING**

NATIONAL SMALL ARMS CENTER
CAPABILITIES

- **CRITICAL MASS OF SCIENTISTS, ENGINEERS AND SUPPORTING PERSONNEL**
- **FACILITIES FOR SIMULATION AND MODELING; RAPID PROTOTYPING; ENERGETICS FORMULATION; LOAD, ASSEMBLE AND PACK OF AMMUNITION;DYNAMIC AND FIXED RANGES; EXPERIMENTAL RANGES FOR WARHEADS, HIGH PERFORMANCE COMPUTER ACCESS AND CHEMICAL, PHYSICAL AND METALLURGICAL LABORATORY ANALYSES**
- **REAL-TIME NETWORK TO GOVERNMENT AND MEMBER TEST RANGES**
- **DATA REPOSITORY AND RETRIEVAL RESOURCES**
- **CONSULTATION AND ADVISORY SERVICES**
- **EDUCATION AND TRAINING CAPABILITIES**

NATIONAL SMALL ARMS CENTER
METHOD OF OPERATION

- **MAINTENANCE AND OPERATION FO THE CENTER WILL BE THE RESPONSIBILITY OF ARDEC**
- **RESEARCH AND DEVELOPMENT WILL BE CONDUCTED BY A CONSORTIUM OF INDUSTRY AND ACADEMIA AS THE RESEARCH ARM OF THE CENTER**
- **THE GOVERNMENT WILL CONTRACT WITH THE CONSORTIUM USING A SECTION 845 "OTHER TRANSACTION AGREEMENT(OTA)" (10 USC 2371)**
  - **EXEMPT FROM MOST ACQUISITION LAWS AND REGULATIONS**
  - **PERMITS COMERCIAL RELATIONSHIP**
  - **ALLOWS CO-FUNDING AND PAYMENT OF PROFIT**
  - **CONTROLLED BY A GRANTS OFFICER**

NATIONAL SMALL ARMS CENTER

METHOD OF OPERATION (CONT'D)

- **CONSORTIUM MEMBERS WILL BE BOUND BY A CONSORTIUM MANAGEMENT AGREEMENT OR SIMILAR DOCUMENT**
  - **DEVELOPED BY THE MEMBERS**
- **OPEN RELATIONSHIP BETWEEN GOVERNMENT AND CONSORTIUM**
  - **GOVERNMENT WILL PROVIDE OBJECTIVES AND REQUIREMENTS AT LEAST ANNUALLY**
  - **CONSORTIUM MEMBERS WILL OFFER TECHNICAL SOLUTIONS THROUGH TECHNICAL COMMITTEES**
  - **GOVERNMENT WILL DEVELOP ROAD MAPS, MASTER PLAN, BUIDGET AND ANNUAL PLAN OF EXECUTION BASED IN PART OR WHOLE ON THE CONSORTIUM INPUT**
- **AN ANNUAL BAA WILL ANNOUNCE TECHNICAL PROGRAMS TO BE ACQUIRED AND SOURCE SELECTION CRITERIA**

NATIONAL SMALL ARMS CENTER

METHOD OF OPERATION (CONT'D)

- **PROGRAM EXECUTION WILL BE ACCOMPLISHED BY CUSTOMARY PROGRAM / PROJECT MANAGEMENT METHODS**
  - **CUSTOMERS OUTSIDE ARDEC MAY MANAGE THEIR RESPECTIVE PROGRAMS AND PROJECTS**
- **THE CENTER WILL HAVE A FULL TIME TECHNICAL DIRECTOR**
- **THE CONSORTIUM WILL HAVE A FULL OR PART TIME ADMINISTRATIVE DIRECTOR**
- **THE OTA AGREEMENT IS EXPECTED TO RUN FOR 5 YEARS AND BE RENEWABLE FOR AN ADDITIONAL 5 YEAR TERM**

PAYOFF FOR INDUSTRY AND ACADEMIA

- **BETTER UNDERSTANDING OF GOVERNMENT NEEDS AND PLANS**
- **OPPORTUNITY TO INFLUENCE CONTENT AND PRIORITIES OF ARMY'S RESEARCH AND DEVELOPMENT PROGRAM**
- **COLLABORATION AMONG MEMBERS AND GOVERNMENT**
- **COMPETITION FOR RESEARCH FUNDING LIMITED TO CENTER MEMBERS**
- **SIGNIFICANT INCREASES IN FUNDING FOR RESEARCH AND DEVELOPMENT AND FOLLOW-ON PRODUCTION**
- **TECHNOLOGIES TO REACH PRODUCTION MORE QUICKLY**

PAYOFF FOR ARMY

- **STRONG, LONG TERM RELATIONSHIP WITH INDUSTRY AND ACADEMIA**
- **CRITICAL MASS OF SCIENTISTS AND ENGINEERS**
- **ACCELERATED RESEARCH AND DEVELOPMENT**
- **POTENTIAL FOR COST SHARING ON SPECIFIC PROGRAMS**
  - **GOVERNMENT / INDUSTRY**
- **SUPERIOR PROGRAMS AND PRODUCTS FOR WARFIGHTERS AND HOMELAND DEFENSE**
- **GROWTH IN TECHNOLOGY AND INDUSTRIAL BASE**

EME

NATIONAL SMALL ARMS CENTER
MILESTONES

TASK	EST COMP DATE
• APPROVAL OF NATIONAL SMALL ARMS CENTER CONCEPT	31 MAY 2002
• PUBLISH BAA ANNOUNCING INDUSTRY DAY AND REQUESTING SHOW OF INTEREST	14 JUN 2002
• INDUSTRY DAY	16 JUL 2002
• INDUSTRY DAY II (IF NECESSARY) TO RESOLVE ISSUES, OBTAIN MEMBERSHIP PLEDGES	14 AUG 2002
• DRAFT AND COORDINATE OTHER TRANSACTION AGREEMENT AND CONSORTIUM MEMBER AGREEMENT	15 NOV 2002

EME

NATIONAL SMALL ARMS CENTER
MILESTONES (CONT'D)

TASK	EST COMPL DATE
• SUBMIT DRAFT OTHER TRANSACTION AND CONSORTIUM MEMBER AGREEMENTS TO REGULATORS (FTC & DOJ)	22 NOV 2002
• COMPLETE COORDINATION AND REGULATORY REVIEWS OF AGREEMENTS	3 DEC 2002
• INDUSTRY AND ACADEMIA SIGN CONSORTIUM MEMBER AGREEMENT, CENTER IS OPENED	8 JAN 2003
• OTHER TRANSACTION AGREEMENT SIGNED WHEN FUNDS ARE RECEIVED	TBD

Marine Corps Systems Command

National Defense Industrial Association

Joint Services Small Arms Section

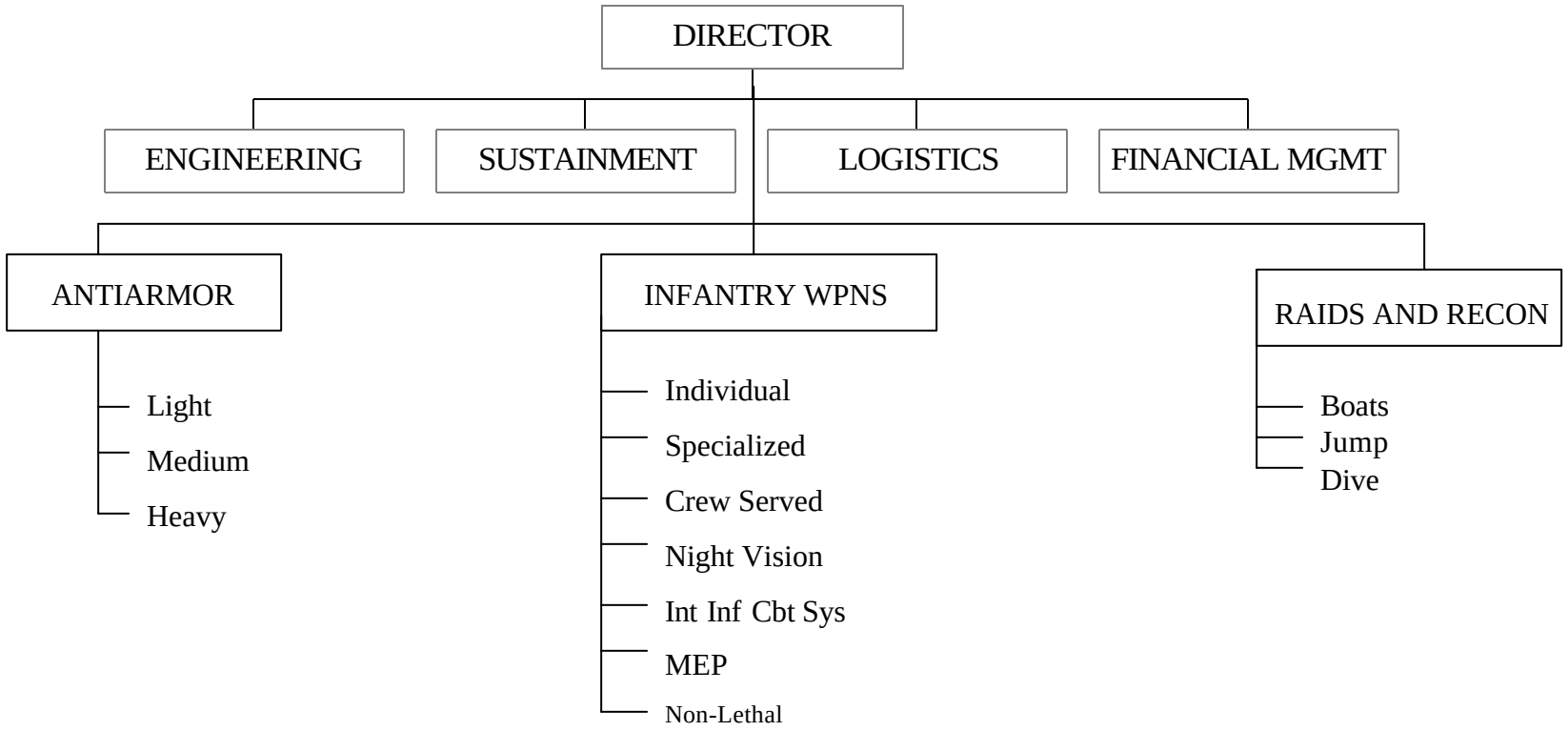
Annual Conference

Mr. Dave Hansen

MISSION

Plan for and execute the approved programs for all Research, Development, Acquisition, Fielding, and Life Cycle Support for assigned equipment and weapon systems

INFANTRY WEAPONS SYSTEMS



INFANTRY WEAPONS SYSTEMS PRODUCT GROUP - DIRECTORATE

Overall goals

- **Rebuild readiness**
- **Assist in Determination of requirements to improve capability and lethality**
  - **Infantry Weapons (Small Arms, Mortars)**
  - **Night Vision (Night/Day Optics, Lasers)**
  - **Non-Lethal**
- **Areas of industry interest**
  - **Mortars**
  - **Modular Weapons System (free float rail system, optics, weapon enhancements)**
  - **Improvements: e.g., laser coatings on optics; camouflaged weaponry, light weight tripods, extended life machine gun barrels, M203 replacement, air-bursting/proximity fuzes for low velocity 40mm grenades, automatic rifles for the inf squads, flash hiders and suppressors, slings and spare barrel bags**
  - **Optics: Sniper Rifle Scope replacement, Rifle Combat Optic, Fusion devices**
  - **Non-Lethal: Shotgun ammo (cycle M1014)**

Means of Contact

Mr. Dave Hansen

PM-Infantry Wpns

(703) 784-2006, ext 2747

hansendk@mcsc.usmc.mil



These slides are in support of an oral presentation given by Graham Hawkes

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25 YEARS OF SOLUTIONS

For

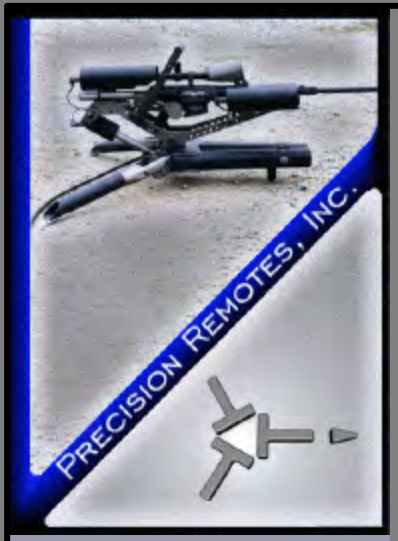
DANGEROUS DUTIES

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DEEP ROVER™



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DEEP FLIGHT 502™



Photo:
H.O.T.

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PRECISION REMOTES, INC.



T-2

TRAP T-2™

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PRECISION REMOTES, INC.



T-250

TRAP T-250™

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Current APPLICATIONS

- **FACILITIES SECURITY**
- **(NETWORKED SECURITY SYSTEMS)**
- **REMOTE OBSERVATION POST**
- **USMC- SHIP/EMBASSY/OTHER**
- **USAF- EXPLOSIVE ORDNANCE DISPOSAL**
- **REMOTE SNIPER-OBS. POST**

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PRECISION REMOTES, INC.



FS

TRAP T2-FS™

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TRAP T-2 FS™

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TRAP T-2 FS™

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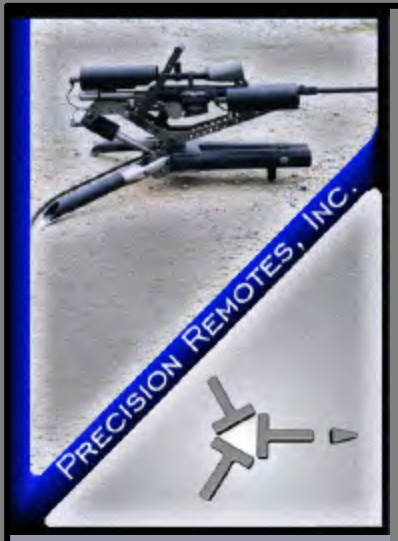
TRAP O2-200™

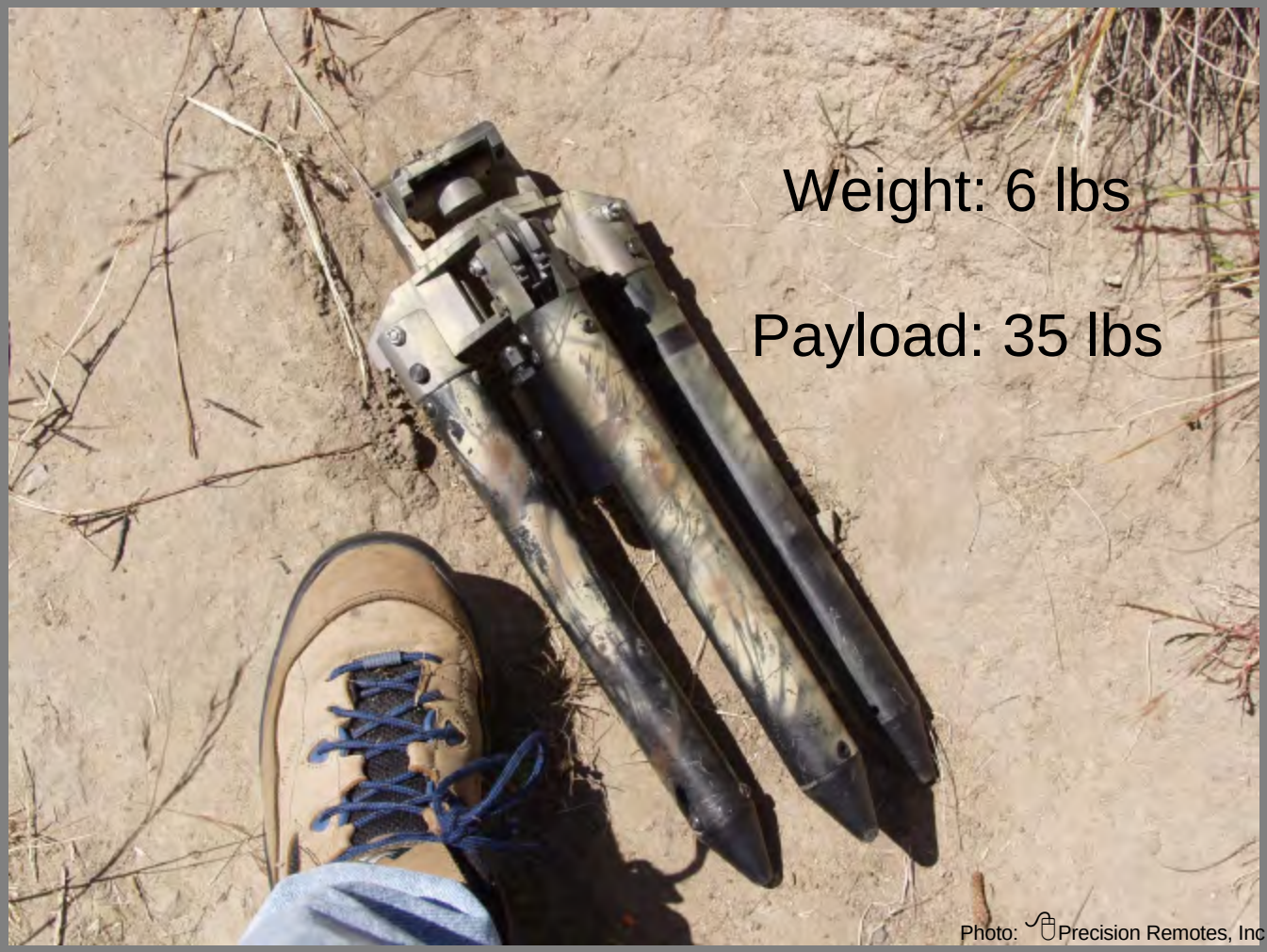
w/ DAVRO™ LENS



Photo: Precision Remotes, Inc

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TRAP O1-100™

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TRAP O1-100™



Weight: 6 lbs / Payload: 35 lbs

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USMC

Photos: Precision Remotes, Inc

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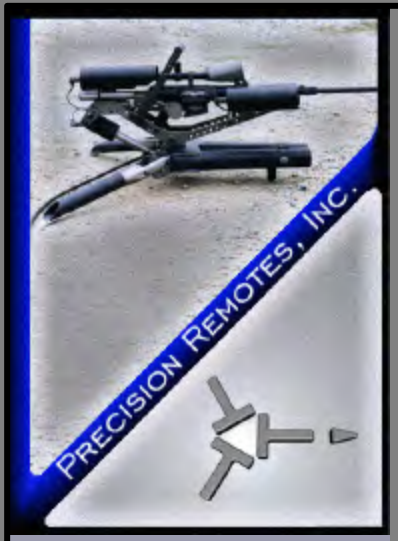






Photo: © Precision Remotes, Inc

USAF EOD

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T-250: .50cal. w/ M82-A1





EOD

PUTLOS GERMANY

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TRAP T-2™ 5.56mm



Photo: Precision Remotes, Inc

REMOTE SNIPER OBSERVATION POST

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FUTURE POSSIBILITIES

AFTER 100 years

A RETURN TO

THE LETHALITY OF ACCURACY

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COMBAT ACCURACY

WEAPONS:

Benched ASSAULT RIFLE = 1 moa
Benched SNIPER RIFLE = ½ moa

RANGE CONDITIONS:

SNIPER = 1 moa
TRAP = 1 moa

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UNDER FIRE

PERFORMANCE

SOLDIER:
(Snap Shot est. less than 1 sec)=100moa

SOLDIER+TRAP +assault rifle
(less than 1 sec) = 3 moa

REQUIREMENTS

ACCURACY REQUIRED est. = 5moa

TIME REQUIRED est. less than = 1.5 sec

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PROBABILITY UNDER FIRE

SOLDIER 1:400

SOLDIER + TRAP (close to) 1:1

Note : All above assume combat range of 100yds. All estimates involving soldier performance are approximate.

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CRITICAL ISSUE

NET ZERO WEIGHT ?

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WEIGHT

Crew served M2	92 lbs (est.)
1000 ROUNDS AMUNITION	250lbs (est.)
Total =	342lbs

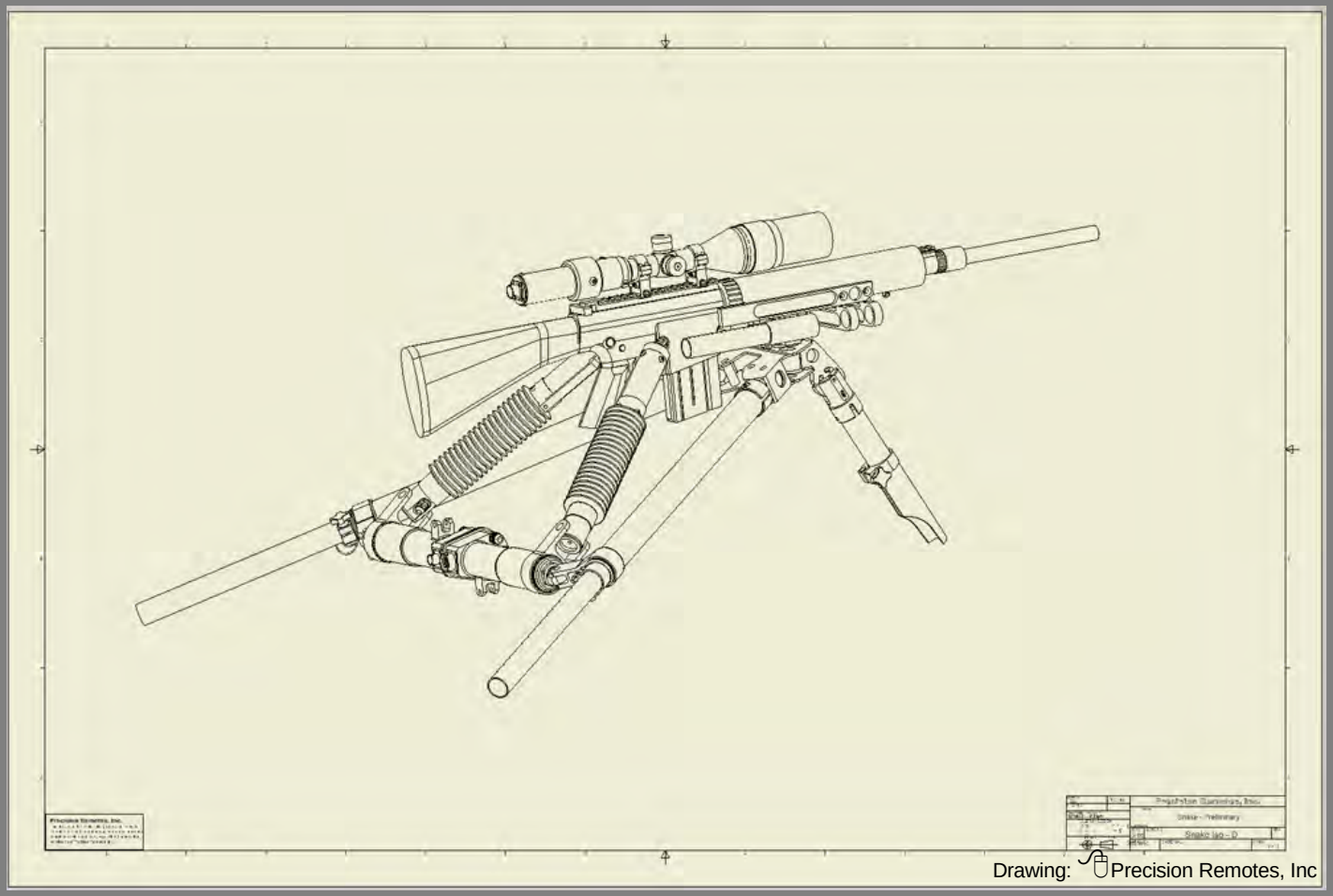
TRADE FULLY AUTOMATIC 50cal. FIRE POWER
for
ONE ROUND ONE KILL LETHALITY

BARRETT M82-A1	42lbs (est.)
100 ROUNDS	25lbs (est.)
REMOTE SYSTEM	15lbs (est.)
Total :	82lbs

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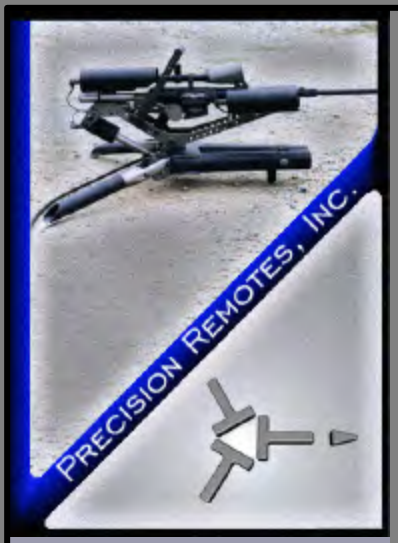


SNAKE™



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SNAKE™ SR25

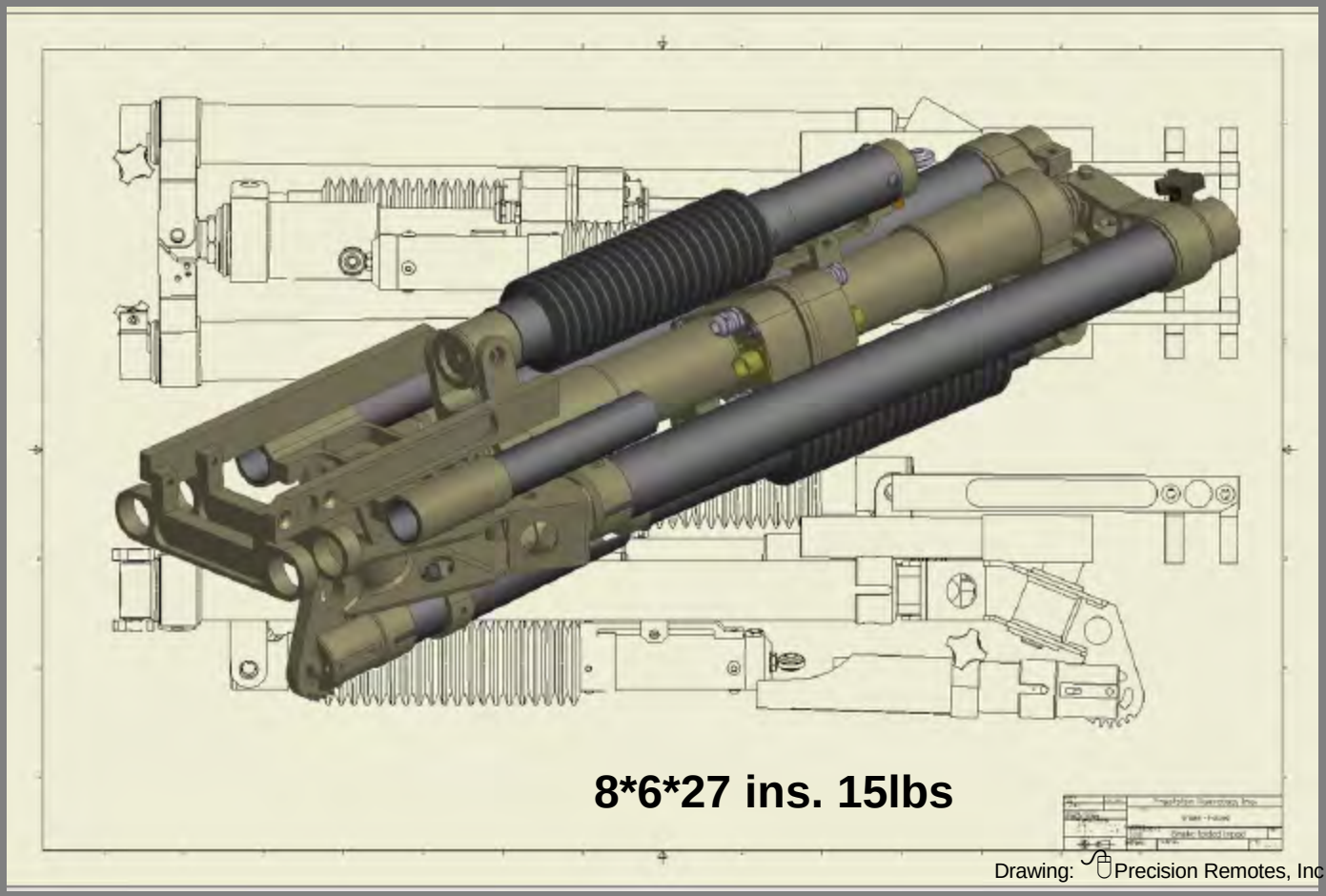


Drawing: Precision Remotes, Inc

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SNAKE™ FOLDED



8*6*27 ins. 15lbs

Drawing: Precision Remotes, Inc

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END

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Moving Weapons Platform Simulator
(MWEPS II)

Presented by

Dawn Hoffa

Hoffa_Dawn@Crane.Navy.Mil

(812) 854-4790



16 May 2002

Overview

- Engineering Need
- Training Need
- MWEPS II Description
- Virtual Target Gunnery System (VTAGS)
- Summary

Engineering Need

- Crew Served Platforms
  - Less costly/subjective performance rating is needed
- Stabilized Remote Operated Platforms
  - More testing time is required for more complex platforms
  - Quantitative data is required to determine performance
  - Realistic specifications need to be determined

VIDEO

Training Need

- More “Weapons Free” opportunities are needed
- Training for night situations is required
- Training for various sea state conditions is required

MWEPS II Description

- Provide Engineering Test and Training Platform for Small Arms, Mounts and EO Sensors
  - Motion base platform
  - Computer generated scenario on a large screen
  - Engagement of targets for training
  - Engineering feedback collection
  - Live fire engineering test compliment
  - Scarce training range time supplement
  - Performance model for future acquisition/development creation

MWEPS II Description



Existing MWEPS I Platform

Fleet Training Center, Dam Neck, VA

MWEPS II Description

Visual Presentation Screen



MK V Special Operations Craft

Motion Base Platform

MWEPS II Description

Motion Platform and Software

- 6 Degree of Freedom Motion Platform
- 5000 lb. Payload
- 18 inch stroke length, 30 deg/sec rotational velocity
- Electromechanical Actuators
- Electric Servomotors
- Digital Motor Controls
- Motion Control Electronics Box
- Modified Vendor Motion Platform Software



MWEPS II Description

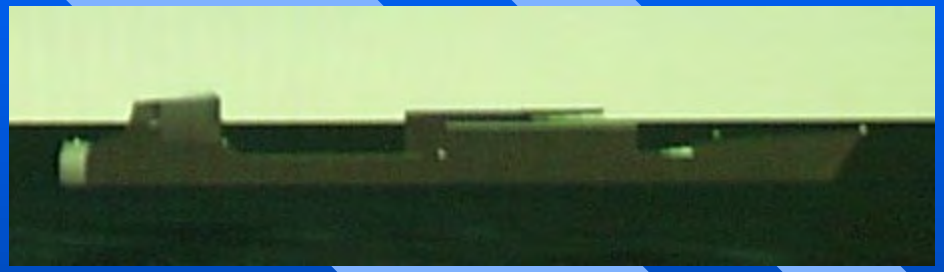
Virtual Environment and Software



- Large Display Screen
- VEGA Marine Software models open ocean scenario

MWEPS II Description

Virtual Targets and Software





- Government generated craft models
- 3 position buoyancy model controls craft motion in response to environment

MWEPS II Description

Tracker and Software

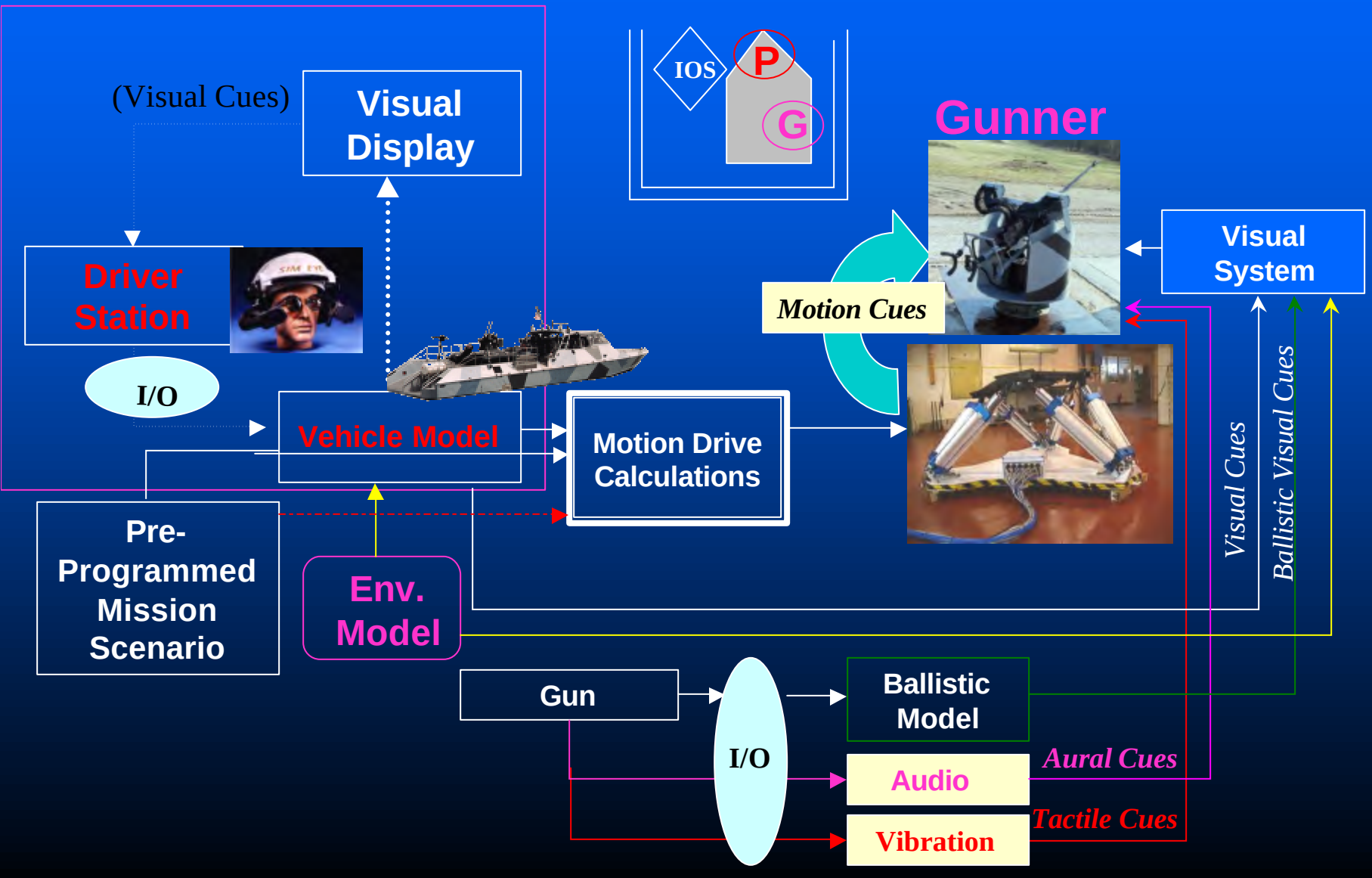
- Gun positional infrared locator
- Screen positional optical tracker
- Motion platform positional indicator
- Computer generated bullet trajectory
- Hit or splash model
- Government generated software to determine performance

MWEPS II Description

Repeatable Simulation Scenario

- Open ocean environment
- Single inbound threat
- Engage hostile target
- Evasive maneuver to break aim point
- Reengage hostile target
- Score hit, miss and aiming criteria

MWEPS II Description



MWEPS II Description

Future Development

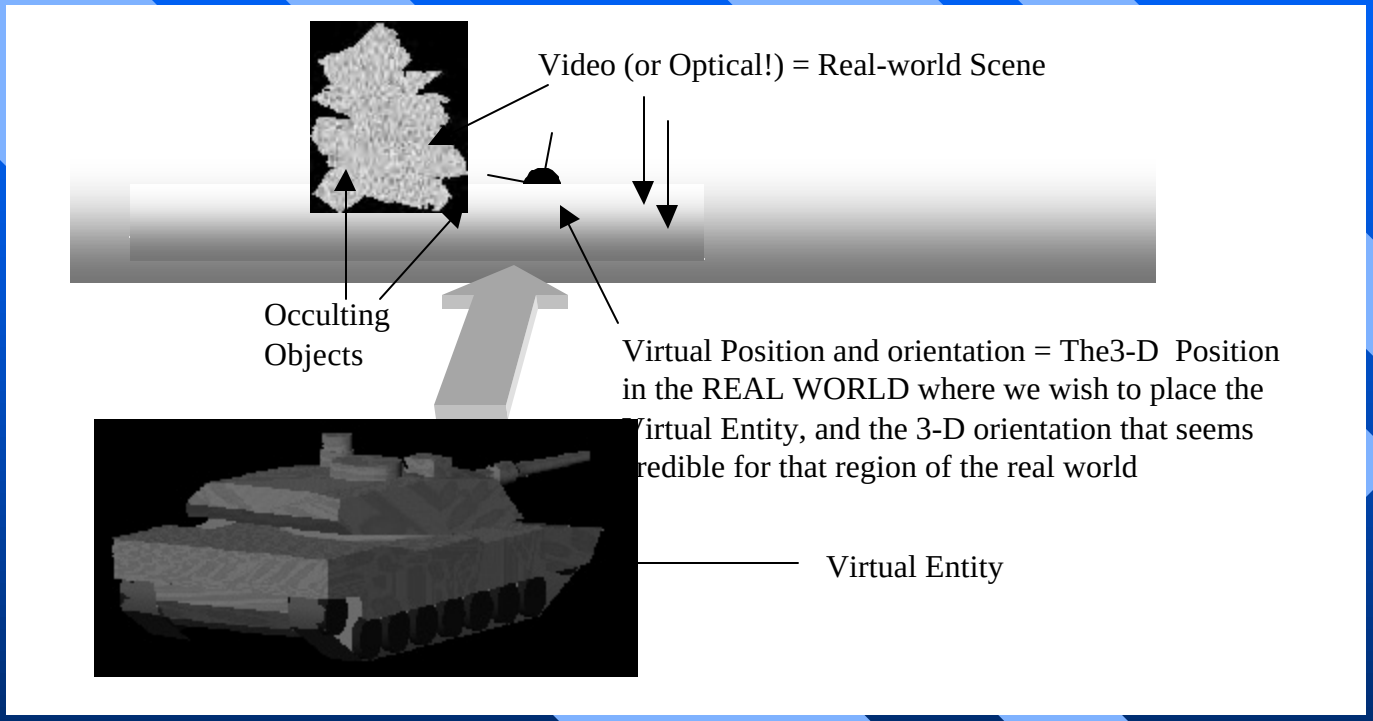
- **Additional Craft & Weapons**
  - **Rotary Wing - NAVAIR**
  - **Vehicles - USASOC, USMC**
  - **Fleet Assets**





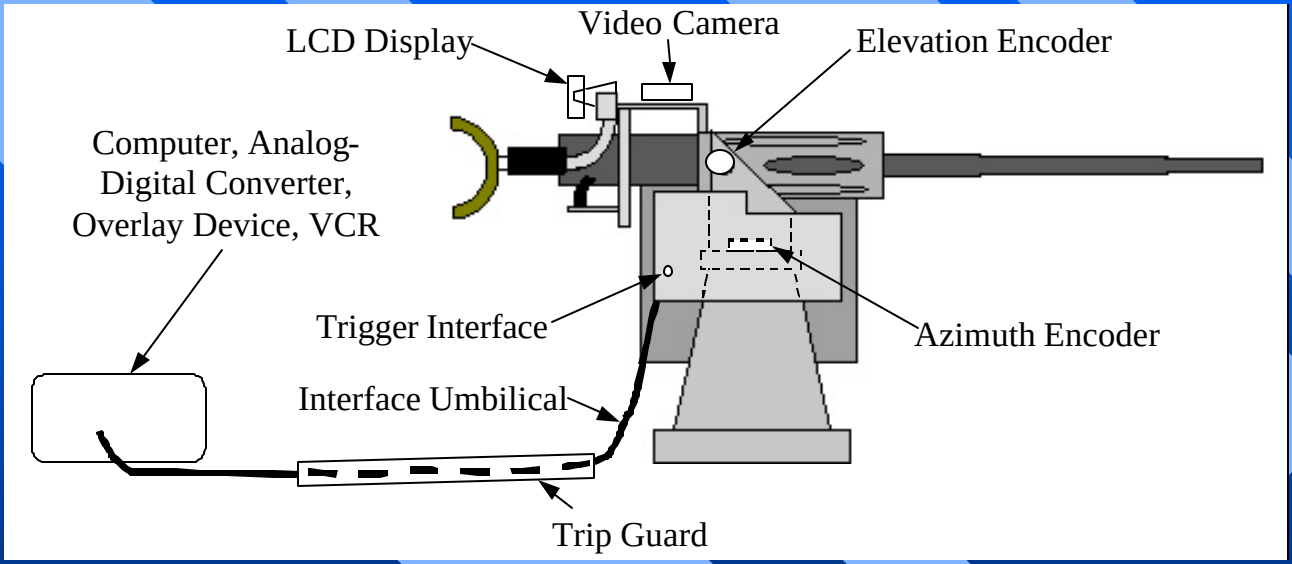
- **Mission Level Scenarios**
  - **Increased Visual Presentation**
  - **Involve More Training Participants**
  - **More Scenarios**
  - **Connectivity to Other Simulators**

Virtual Target Gunnery System (VTAGS)



- Permits gunner to engage virtual targets superimposed onto view screen
- Can be used w/ live fire or can generate simulated fire
- Gives quantitative data to determine performance

Virtual Target Gunnery System (VTAGS)



- Easily mountable virtual training aid
- Used with weapon systems presently installed on maritime platforms
- Selectable scenarios that are skill dependant

Summary

- MWEPS II is needed for engineering
- MWEPS II is needed for training
- MWEPS II can fulfill both of these needs on land
- VTAGS can fulfill the training needs at sea and is easily installed on existing maritime platforms

TACOM

Lethality, Survivability, Mobility and Sustainment for America's Army

The Challenges of a Green Primer

Presented by:

Hugh A. Huntzinger
TACOM-ARDEC

In association with:

Sung Kim
NSWC-CRANE



Green Ammunition

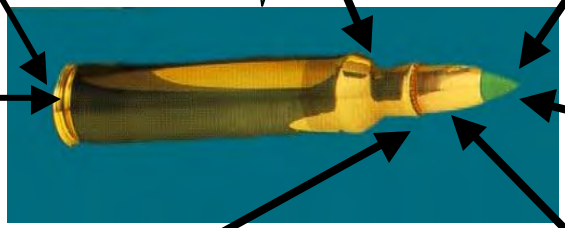
Target Materials

VOCs
Primer Pocket Sealant
Lacquer Thinner MEK
Xylene MIK
Toluene

ODCs
Casemouth Sealant
Methyl Chloroform

VOCs
Blank Ctg Tip Sealant
Ethyl Acetate Toluene
MEK Xylene
MIK

HEAVY METALS
Primer Compositions
Lead Styphnate
Barium Nitrate
Antimony Sulfide



VOCs
Combat Ctg Tip ID
Glycol

Tracer & Ignitor Compositions

VOCs
Ethyl Alcohol

HEAVY METALS
Barium Peroxide
Lead Dioxide
Barium Nitrate

ODCs
Methyl Chloroform

HEAVY METALS
Projectile Slug
Lead\Antimony

Joint Working Group for Non-Toxic Ammunition

CHAIR – TACOM-ARDEC

Naval Surface Warfare Center – Crane
Naval Air Warfare Center - China Lake
Naval Surface Warfare Center - Indian Head
Air Force- AFCEE
Air Force - Randolph AFB
Marine Corps System Command- Arlington
Coast Guard HQ-Washington
National Guard HQ- Arlington
USAIC- Ft. Benning
US Army Reserve Command
Army Center for Health Promotion & Prevention Medicine
Naval Special Warfare - Coronado
Ft Dix Force Projection
Army Environmental Center- Edgewood
Army Training & Support Center- Ft. Eustis

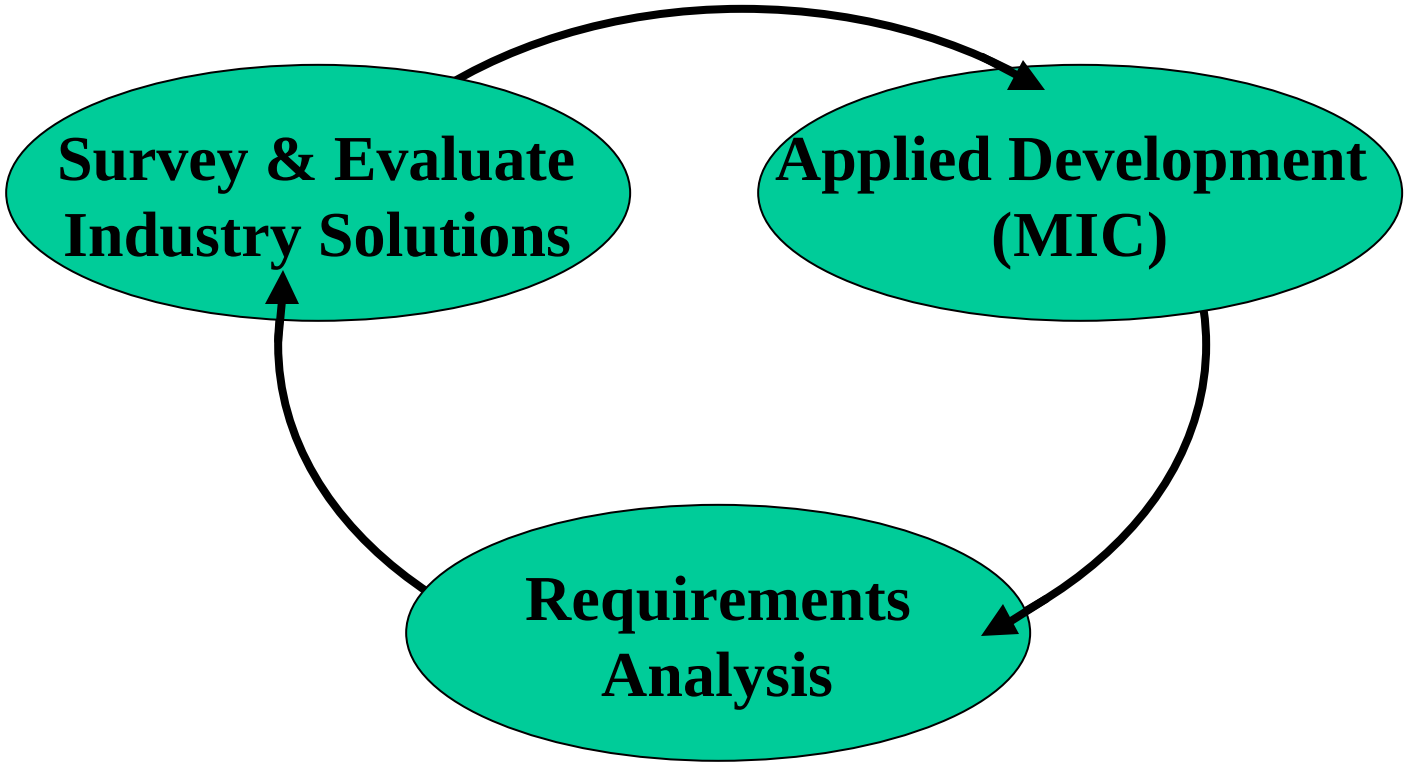
Formed by ARDEC in October 1995

Industrial Operations Command
Lake City Army Ammunition Plant



DOE- Oak Ridge National Lab
DOE- Los Alamos National Lab
DOE- Kansas City Plant
Federal Bureau of Investigation
Federal Law Enforcement Training Center

Green Primer Replacement Effort
Technical Approach



Expected DoD Benefit

- **Projected FY01 - FY03 Heavy Metals Usage for Small Caliber Primers (Avg: 335 M Rounds)**
  - Lead Styphanate: 25,106 lbs
  - Barium Nitrate: 22,928 lbs
  - Antimony Sulfide: 9,410 lbs

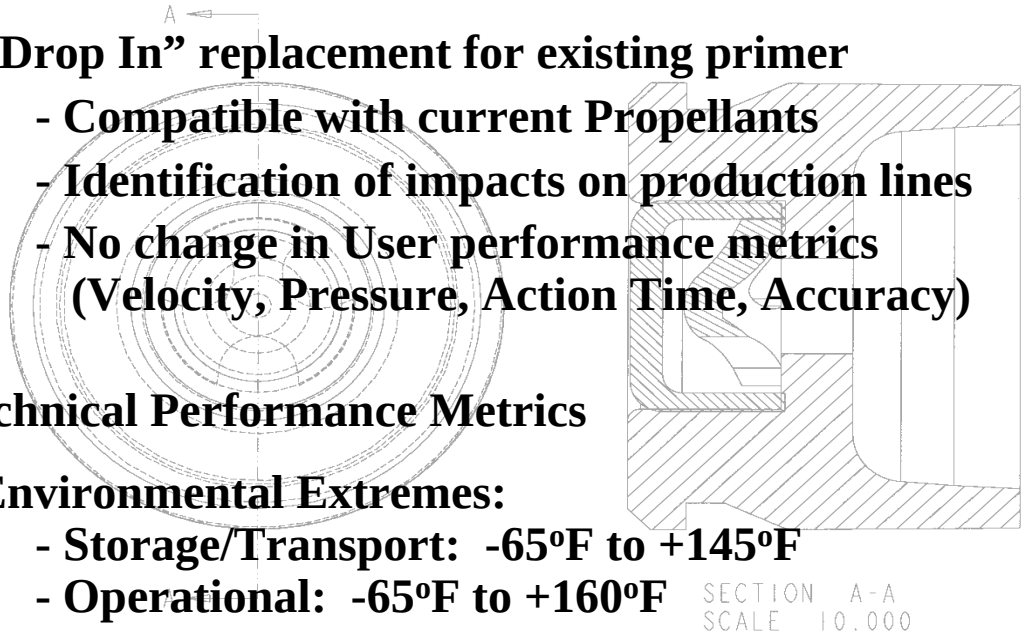
28+ Tons of Heavy Metal Materials

- **Current Process is Labor Intensive & Multi-Stepped**
  - MIC Process is expected to lend itself to Automation
- **Technology will leverage into Larger Calibers**
  - Lead Styphanate Based Variants

Green Primer Replacement Effort
Functional Requirements

Basic Design Objective

– **"Drop In" replacement for existing primer**
- **Compatible with current Propellants**
- **Identification of impacts on production lines**
- **No change in User performance metrics (Velocity, Pressure, Action Time, Accuracy)**



Key Technical Performance Metrics

– **Environmental Extremes:**
- **Storage/Transport: -65°F to +145°F**
- **Operational: -65°F to +160°F**

– **Action Time:**
- **Max Individual <2.5 mSec. (MIL-P-46610; MIL-P-3984)**

– **Ignition Sensitivity:**
- **"All Fire": 12 inches**
- **"No Fire": 3 inches**

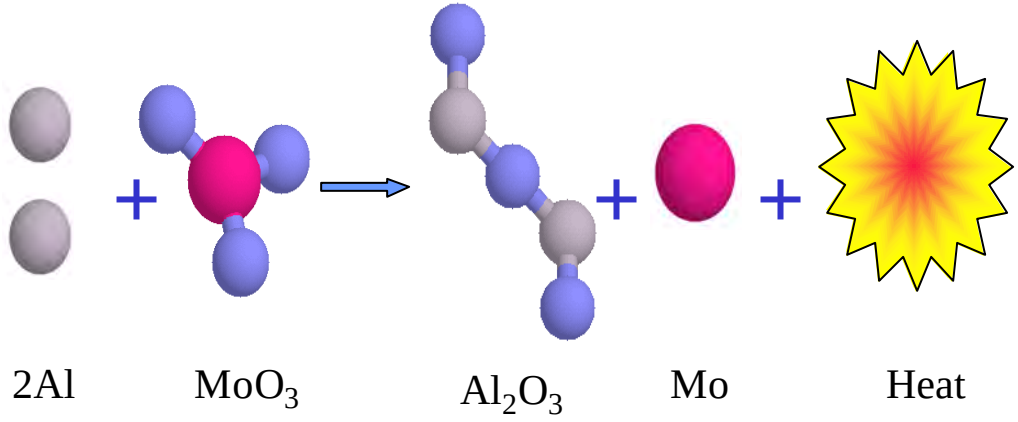
Green Primer Replacement Effort
COTS Industry Solutions

- Prior to FY96 - Services had initiated in-house efforts based on tightening Environmental Regulations
  - Duplication of effort between services
  - Evaluation Process not firmly Structured or Coordinated
- Several potential contenders were investigated, to varying depths. Key performance shortcomings included:
  - Insufficient extreme cold temperature performance
  - Hydroscopicity
  - Primer Sensitivity concerns
- FY96 - JWG Formed; first joint MIC R&D effort initiated

Green Primer Replacement Effort
Metastable Intermolecular Composites (MIC)



5.56 mm primer cup & anvil





MIC-loaded 5.56mm primer

- ✓ **New Family of Highly Energetic Materials**
- ✓ **Tailored from Joint DoD\DoE Development Program**
- ✓ **Function Not Effected by Temperature**
- ✓ **Resistant to Water Degradation**

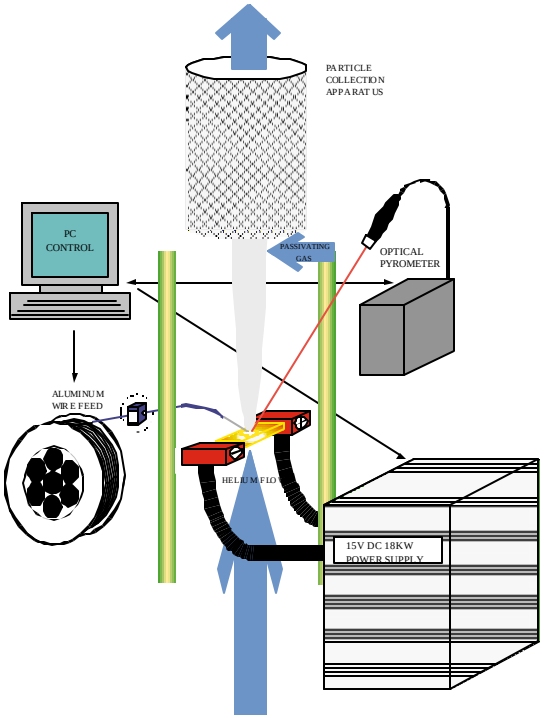
Green Primer Replacement Effort

METASTABLE INTERMOLECULAR COMPOSITES

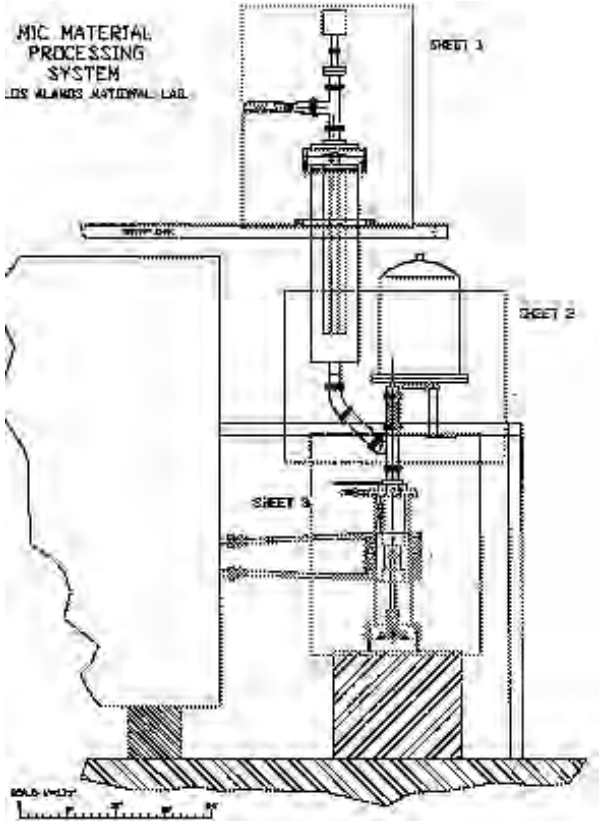
MIC Accomplishments

- Joint Working Group for MIC Formed
- Demonstrated transfer of technology from DOE
- MIC Laboratory established at ARDEC
- Demonstrated methods of standardized characterization
- Supported NSWC with equipment and characterization
- Scaled-up LANL reactor output
- Technology Transfer to Industry of MoO_3

UFAL/UFM Reactors
LANL Tech Transfer



IHDIV Resistance Heating Reactor



ARDEC RF Heating Reactor

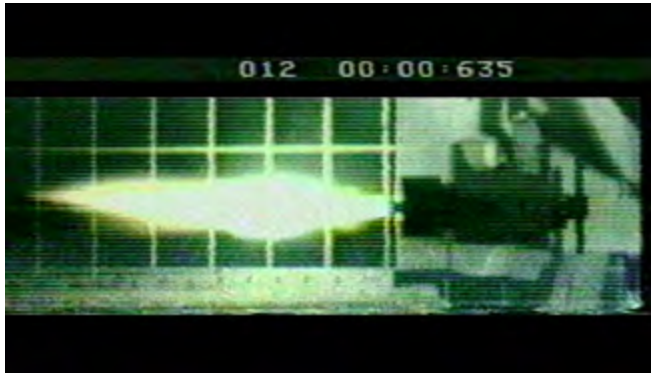
MIC Primer Flame Tests

PVU-1/A Primer



1.0 msec Duration

MIC Primer



t = 1.0 msec

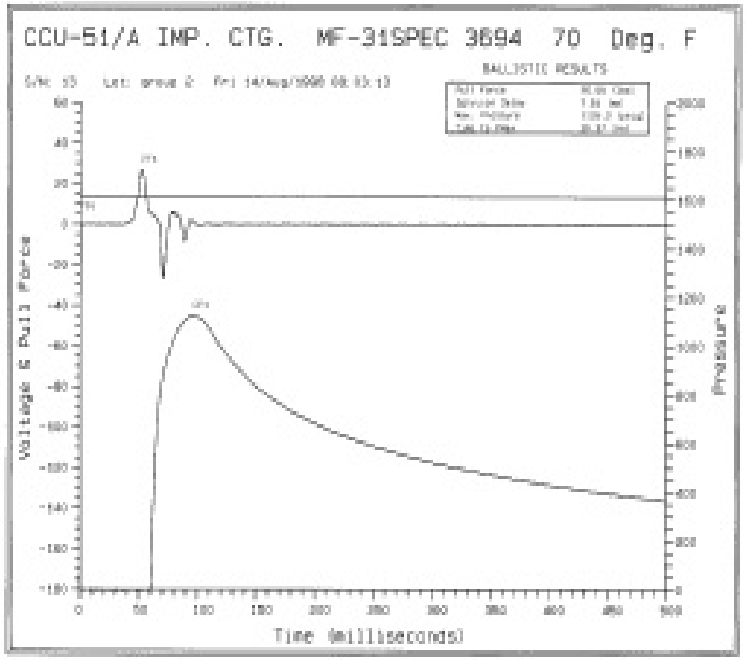


t = 5.0 msec

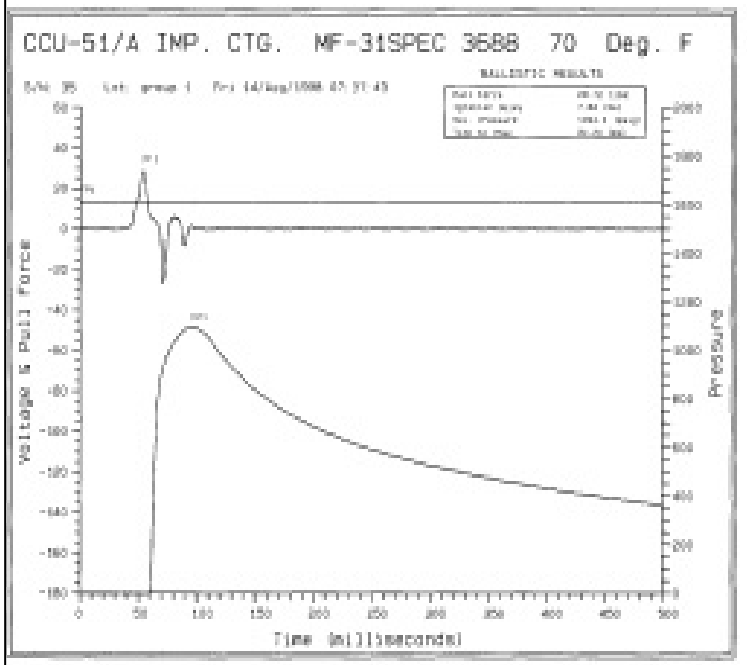
>3000 primers have been loaded and tested

CCU-51/A Test Results

- MIC Primer

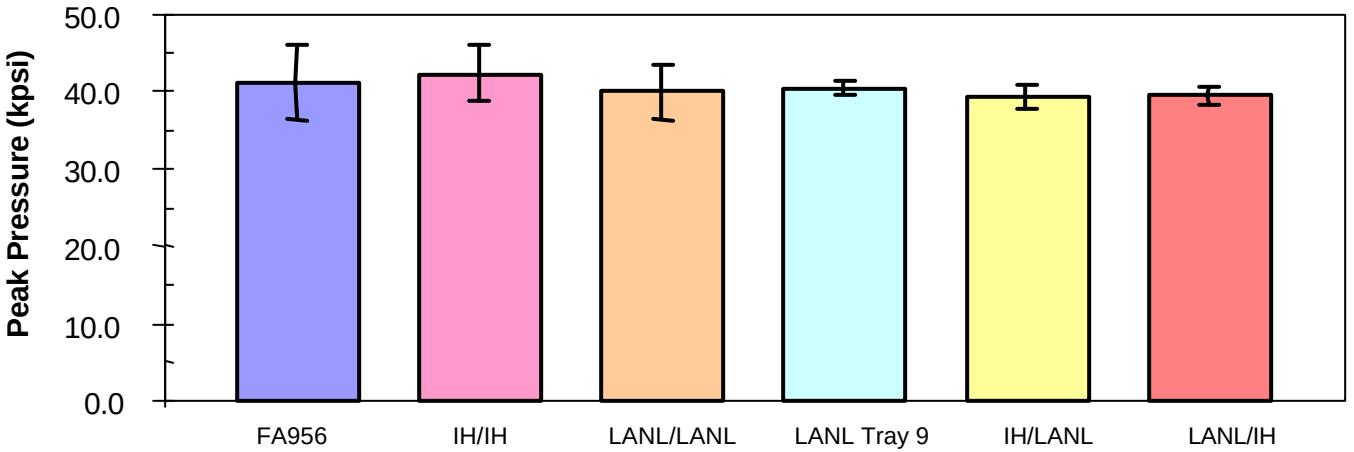


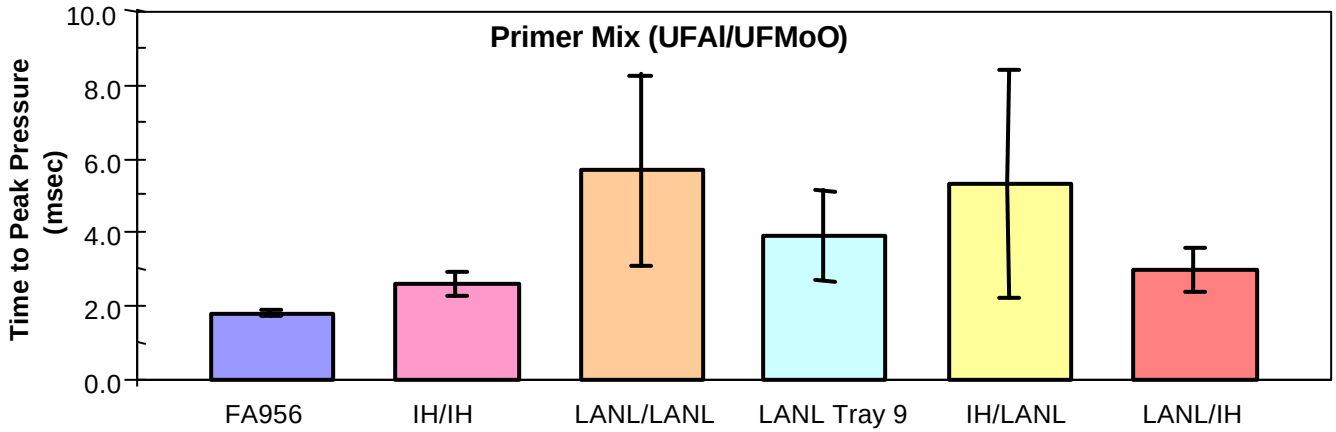
- Standard PVU-1/A Primer



- **No Change in Cartridge Internal Ballistics**

5.56mm #41 Primer Test Results

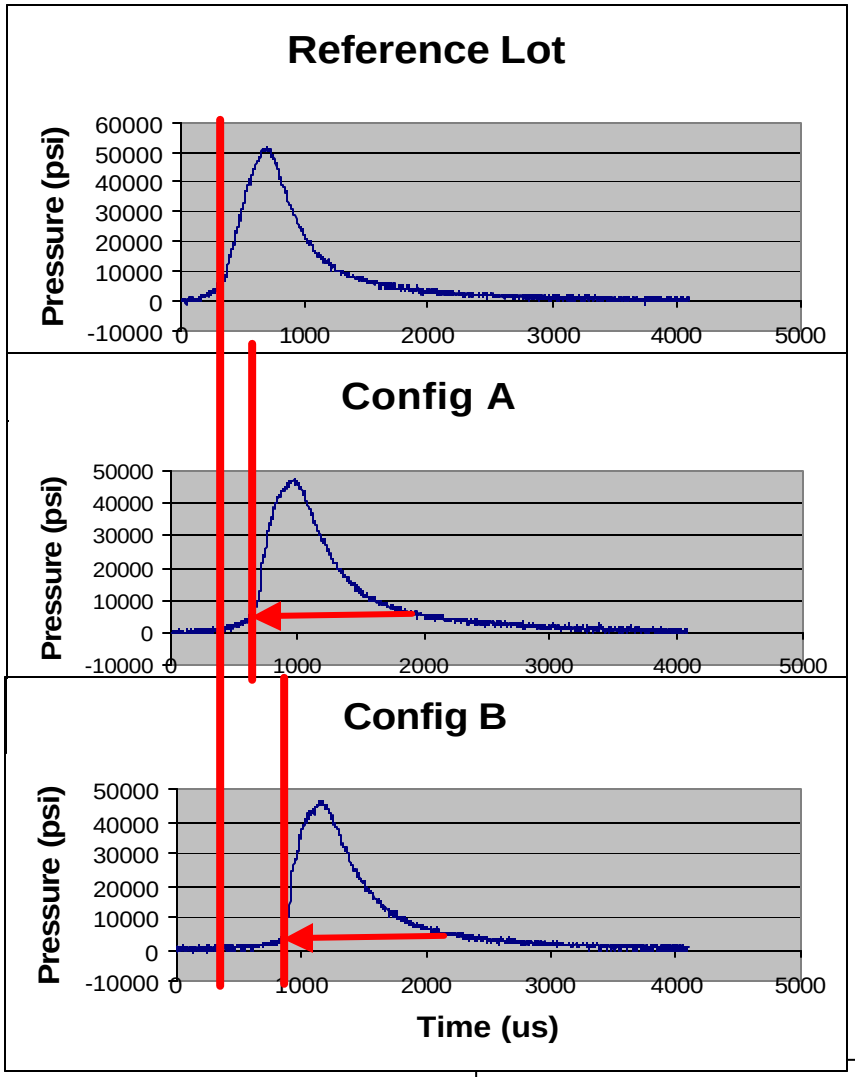




- **Pressures approaching Lead primer Mean & Standard Deviation**
- **Time to peak pressure approaching Lead primer values**

Green Primer Replacement Effort

METASTABLE INTERMOLECULAR COMPOSITES



Ballistic Results:

- Velocity OK
- Pressure OK
- Port Pressure OK
- *Slower Action Time*

Safety Testing:

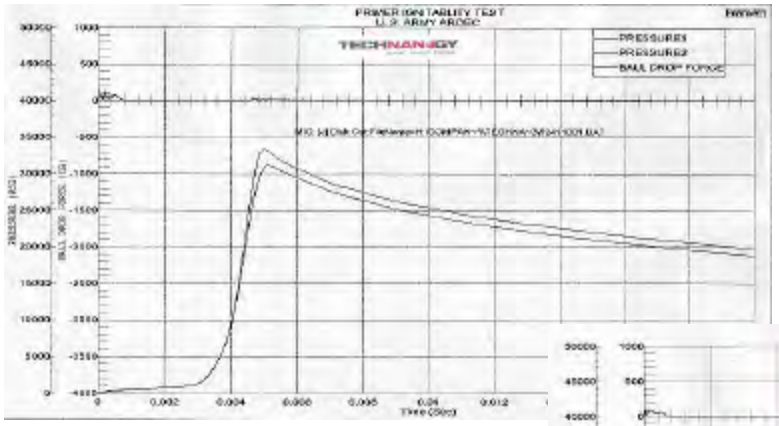
- *High Electrostatic Sensitivity*

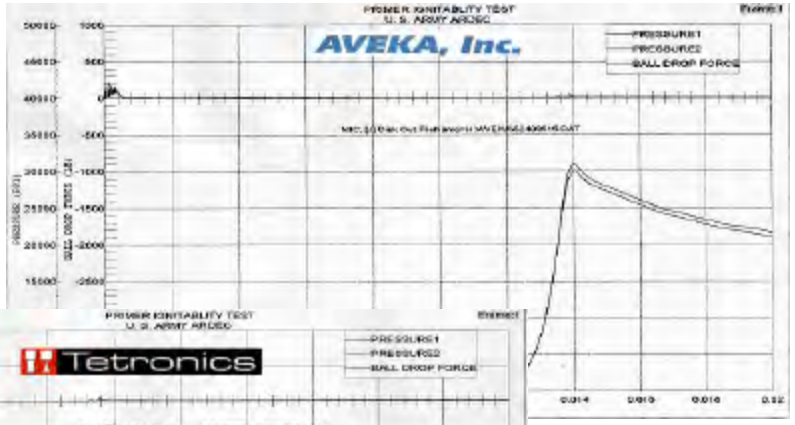
Conclusion:

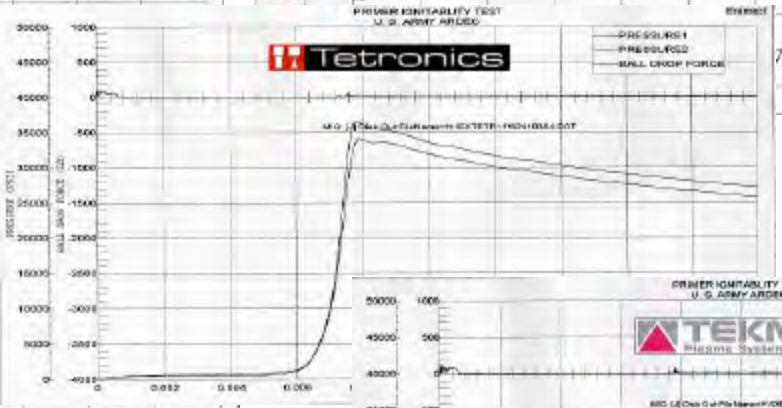
- Requires continued Development

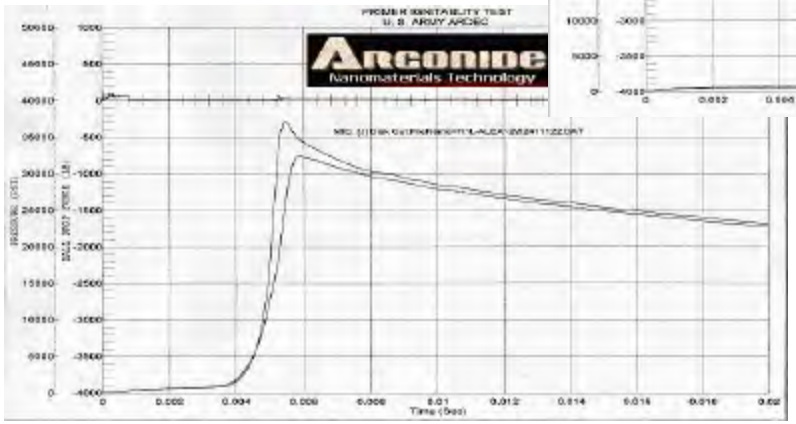
Characterization

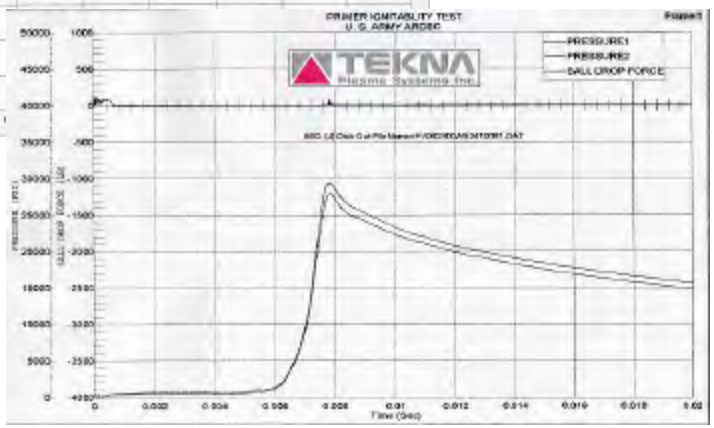
Commercial Nano Aluminum











Green Primer Replacement Effort
COTS Industry Solutions

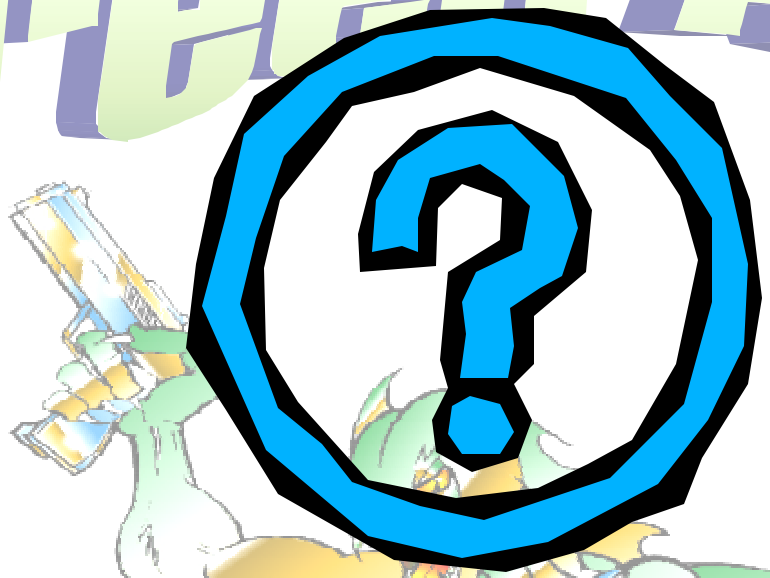
- **FY01:** JWG Decision to formally evaluate Commercial Alternatives to MIC by Group.
- **CY 01:** Two CBD Announcements for proposed COTS candidates; several responses received.
- **Present:** Three (3) COTS samples purchased and received at CRANE; being shipped to ATK, LCAAP for loading.
- **Near Future:** 'Fast Track' test to determine if if the previously identified COTS performance deficiencies have been resolved, with Go/NoGo for a follow-on qualification program.

Green Primer Replacement Effort

The Challenges:

Requirement	MIC	COTS
Action Time	*x*	*TBD*
Cold Temperature	✓	*TBD*
Hydroscopicity	✓	*TBD*
Process Safety	*TBD*	✓
Process Scaling	*TBD*	✓

Green Ammo



QUESTIONS

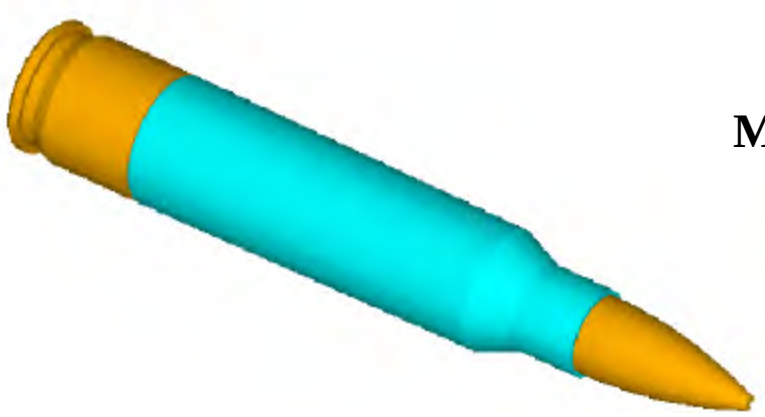
ARROW TECH

If you can't get a bigger target...

amtech

Design, Analysis and Testing of a 5.56mm Polymer Cartridge Case

Mr. Alan Hathaway
Mr. Jeff Siewert
Arrow Tech Assoc, Inc.
So. Burlington, VT



Dr. Nabil Husseini
Ms. Laura Henderson
Amtech, Inc.
Washington, D.C.

2002 International Infantry & Joint Services Small Arms Systems Section
Symposium, Exhibition & Firing Demonstration
Atlantic City, NJ

Outline

- Introduction
- Goals/Objectives
  - Product
    - Benefits
    - Design
    - Material
  - IB/Modeling Analysis
- Polymer Cartridge Case Analysis & Results
  - Analytical Approach
  - Modeling
  - Results/Conclusions
- Project Status
  - Additional Studies
  - Testing/Interest

Goals/Objectives

- Polymer-Cased Cartridge
  - Function in Existing Weaponry without Modification
  - Meet Objectives of Standard Brass Specification
  - Provide Cost Effective Transition to Production
  - Serve as "Bridge to the Future" for Lightweight Soldier Initiatives
    - Immediate Savings while Longer-Term Development Items Mature



Polymer Case Benefits

- Directs More Energy to Projectile, Reducing Propellant Requirement to Obtain Comparable Ballistics
- Reduces Heat Transference to Chamber (Natural Insulator)
- Reduces Muzzle Flash
- Provides "Dimensional Memory" for Consistent Weapons Feeding
  - Distortion During Transportation/Handling has No Impact on Chambering/Firing
- Reduces Case Rupture Effect
  - Case Easily Removed Without Damaging Weapon
- Reduces Weight Load on Soldier/Aircraft
- Reduces Manufacturing Cost with Simplified Manufacturing Process
  - Requires No Sealant at Projectile/Case Interface; Self-Sealing Production Process

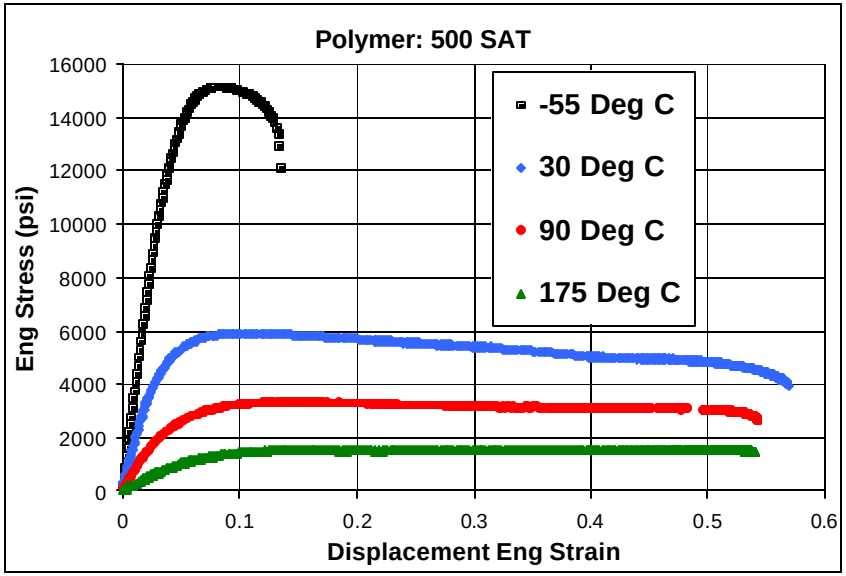
Polymer Case Design

- Design Goals
  - Lightweight Materials that Meet Performance Requirements
    - Minimal "Non-Qualified" Component Materials
  - Manufacturing Process that is Efficient and "Eco-Friendly"
- Current Design Components (5.56mm Cartridge)
  - Zytel Nylon 612 Polymer (Modified - 4th Generation) Cartridge Case
  - M855 62 gr. Full Metal Jacket Boat Tail (FMJBT) Projectile
  - Alloy 260 Cartridge Brass Base Cap
  - No. 41 Military Primer
  - Primer Sealant, High Viscosity Purple
  - WCC 844T Propellant

Polymer Material

- Material Characterization/Accelerated Aging* Studies
  - Plans Developed by NSWC-Dahlgren, Texas A&M, and Amtech, Inc.
  - Testing Conducted by Texas A&M
  - Analysis and Report Written by Texas A&M – Reviewed by DuPont
  - Results Provided to Arrow Tech Assoc.

Stress-Strain Curve



Studies:

- Include DAM (Dry As Molded) and Saturated Test Samples
- Vary Across Contracted Temperature Ranges (Both Storage and Operational)

* Accelerated Aging Study in Progress.

Goals/Objectives

- IB/Modeling Analysis
  - Validate Actual Testing Results
    - Provide Scientific Basis for Demonstrated Performance
  - Facilitate Expansion into Larger Caliber Cartridges
    - Project Feasible Caliber Range
    - Accelerate Incorporation of Design/Component Improvements

Analytical Approach

Perform Modeling and Analysis to Ensure Structural Integrity

- **Analytical Issues:**
  - Brass & Polymer Material Description
  - Chamber Pressure vs. Ammo Conditioning Temp.
  - Case Mouth vs. Chamber Pressure
  - Bolt Mass & Stiffness

- **Case & Chamber Interaction**

Analysis Goals

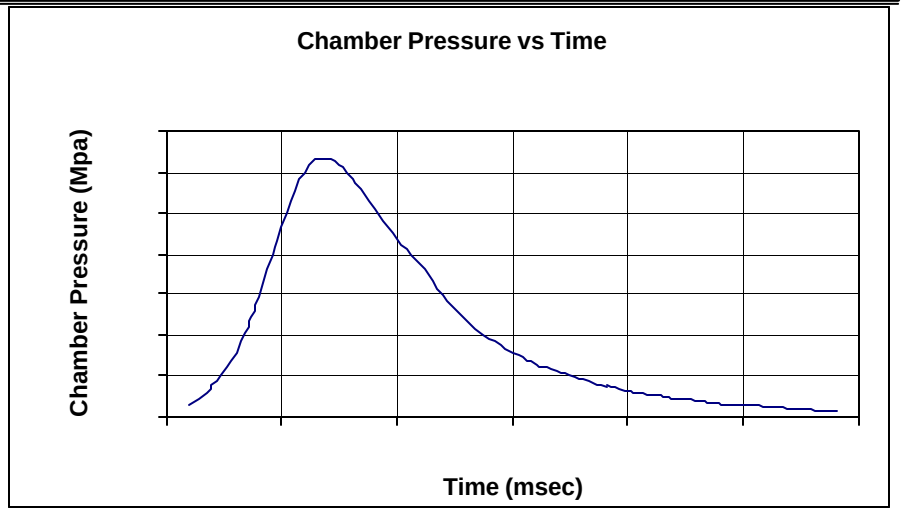
- Interior Ballistics Modeling (from test data)
- Case/Chamber Modeling and Analysis
  - Brass (nominal dimensions at hot, ambient, & cold)
  - Polymer (nominal dimensions at hot, ambient, & cold)
  - Dimensional Parametric Studies
  - Investigate Several Gun Chambers: M4, M16A2 & M249

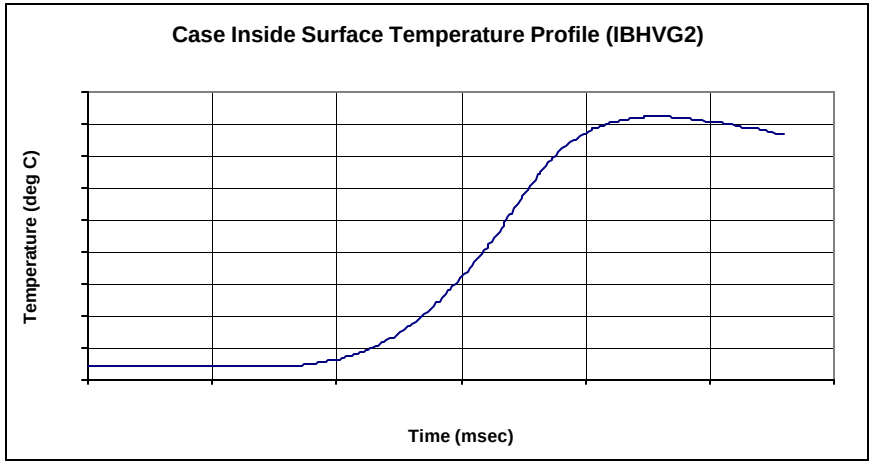
Analysis Approach

- CASAS: CASe Analysis System
  - Elastic-Plastic, Thermal, Dynamic Solution
  - Models the 5 Phases of Case/Chamber Interaction
    - Initial Conditions (temperature, tolerances, etc.)
    - Propellant Ignition
    - Pressure Load Increase
    - Elastic Recovery
    - Residual Interference (or clearance)
  - Evaluate Peak Material Strain and Peak Bolt Loads
  - Lumped Parameter FEM Model
  - Alternative to General Purpose FEM Programs
  - Ideal for Performing Trade-off Studies During Design

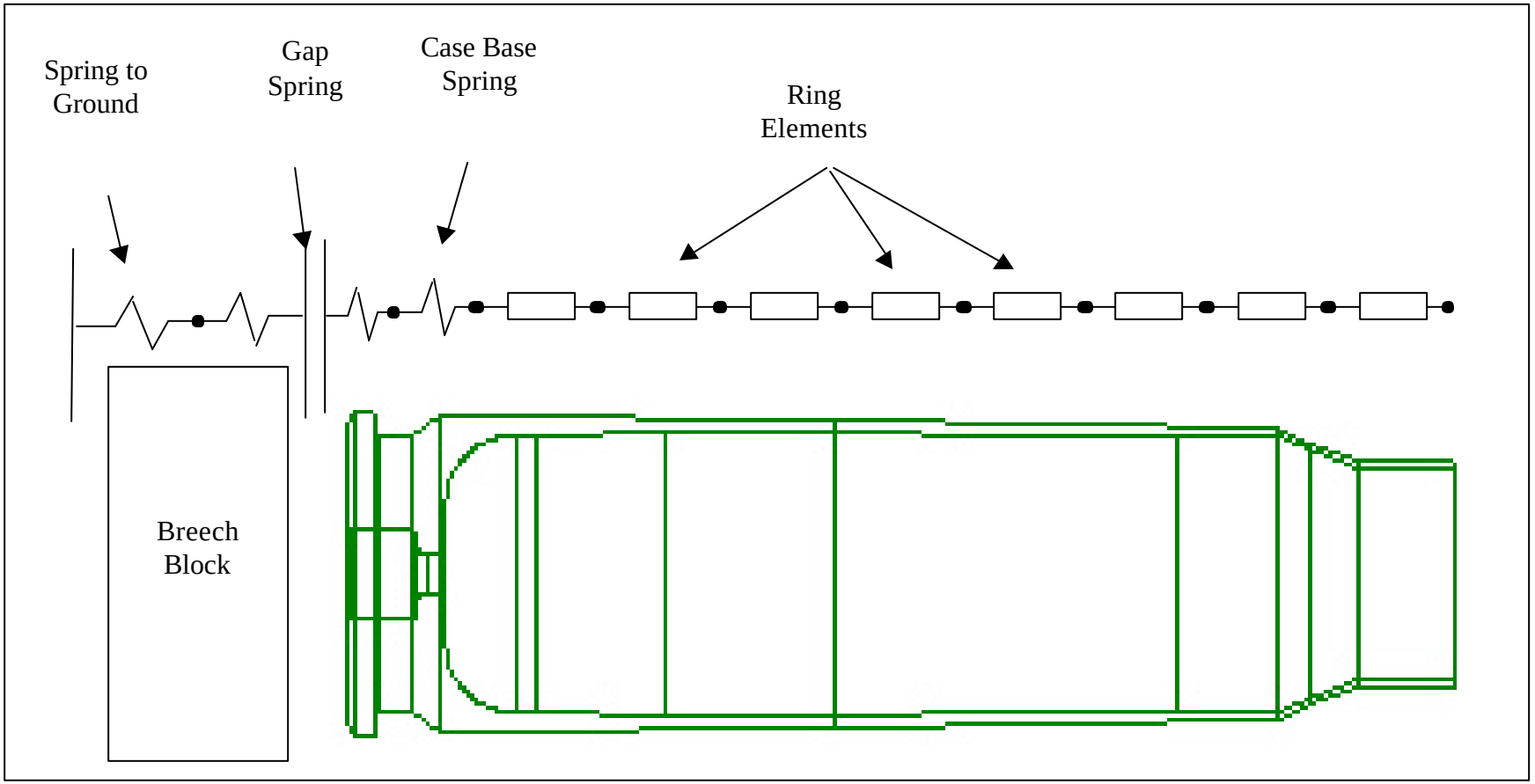
Data Requirements

- Forcing Functions
  - Pressure (P-T Curve)
  - Temperature
- Material Properties
  - Cartridge Case
    - Density, Modulus
    - Diffusivity
    - Coeff. of Thermal Expansion
    - Stress-Strain Curves
  - Chamber
    - Modulus
    - Diffusivity
  - Case/Chamber Interface
    - Static Coeff. of Friction
    - Dynamic Coeff. of Friction



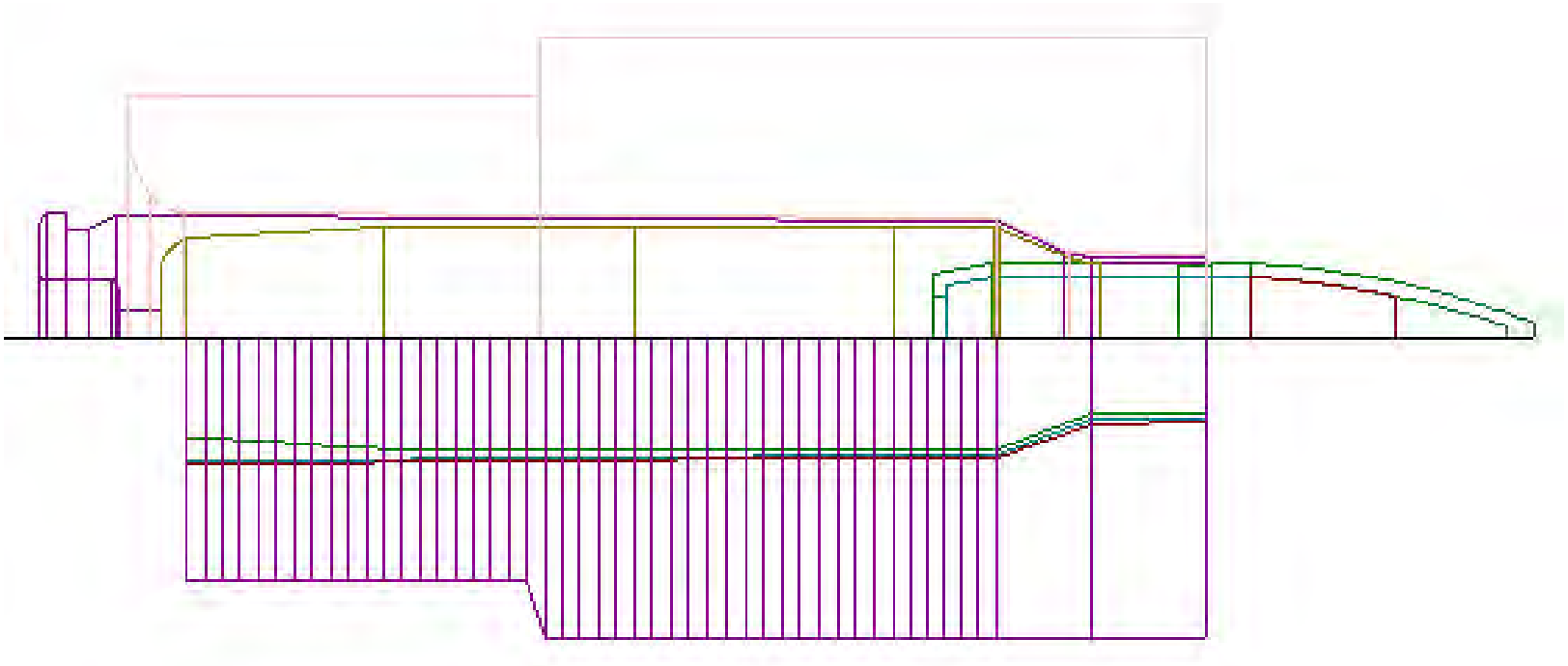


Lumped Parameter Model

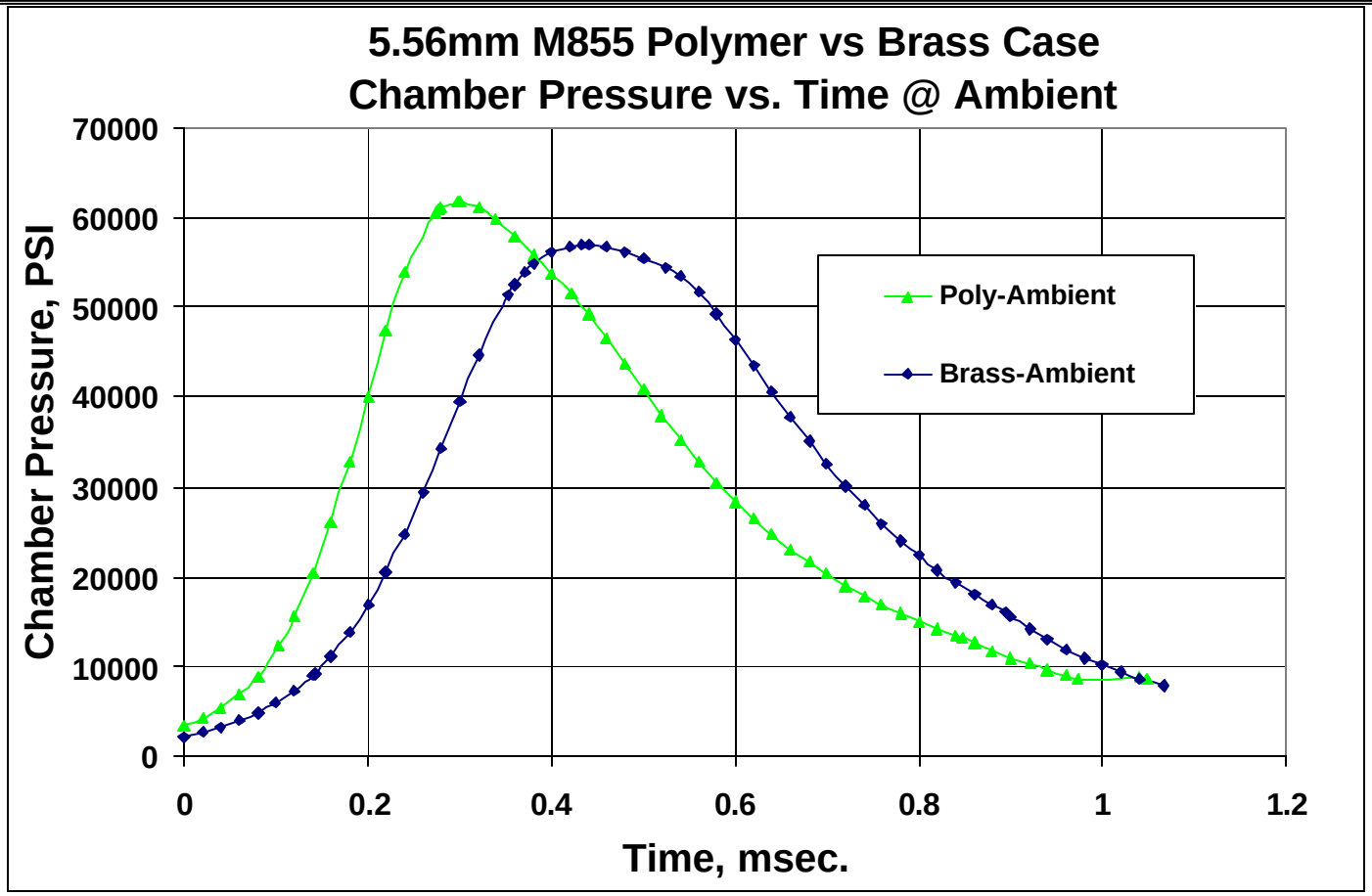


Lumped Parameter Model

Lumped Parameter Model of the Gun Chamber
and the Cartridge Case is Generated
Automatically within PRODAS

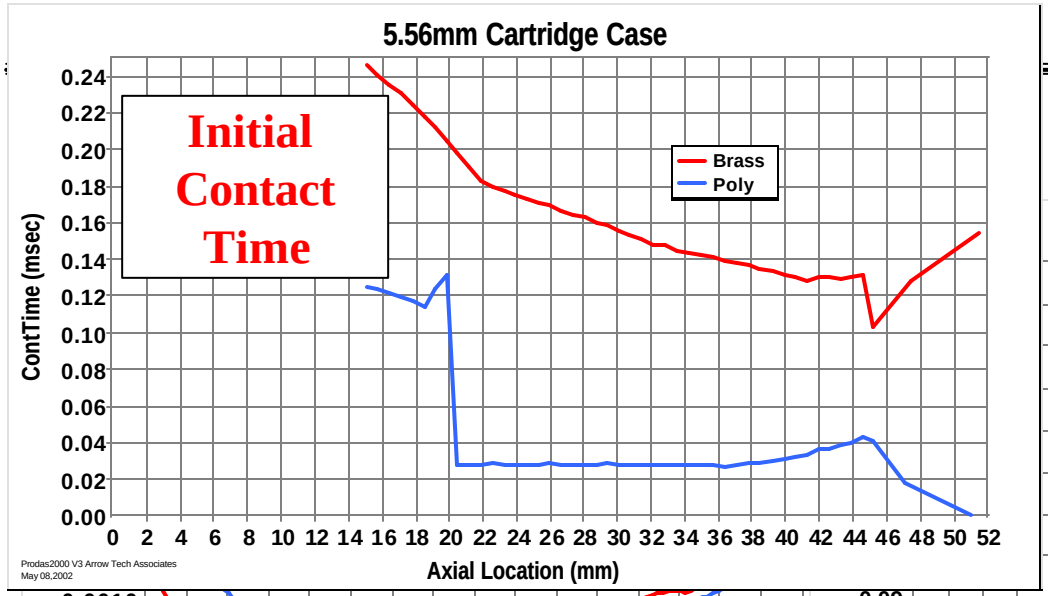


Analysis Results - Ballistics

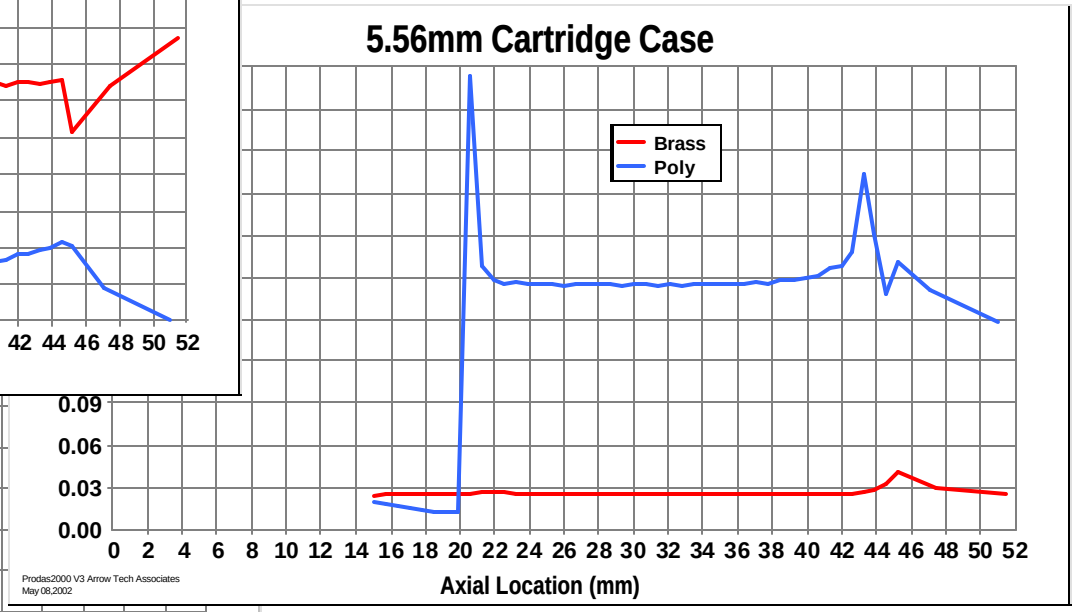


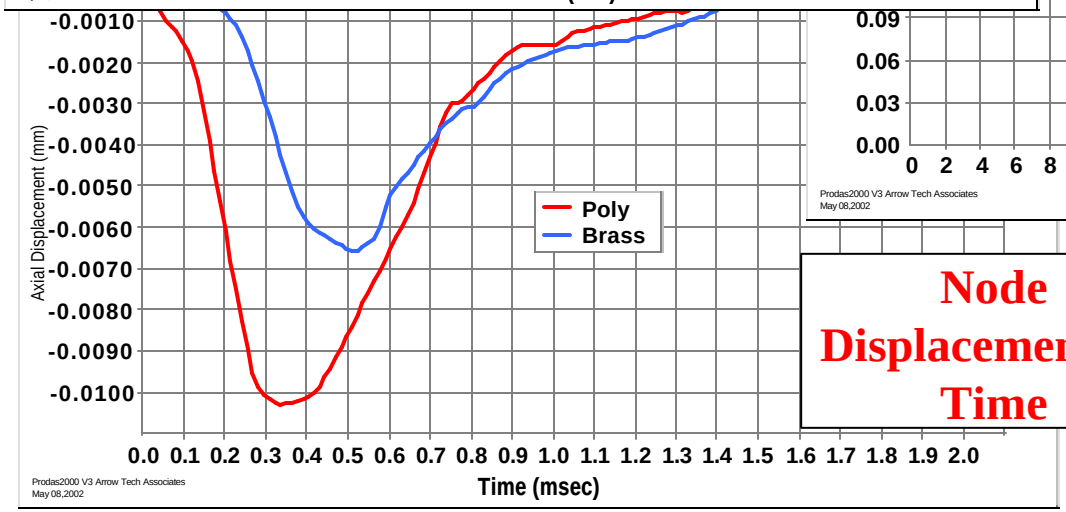
Analysis Results

Initial Contact Time



Total Strain vs. Location





Node Displacement vs. Time

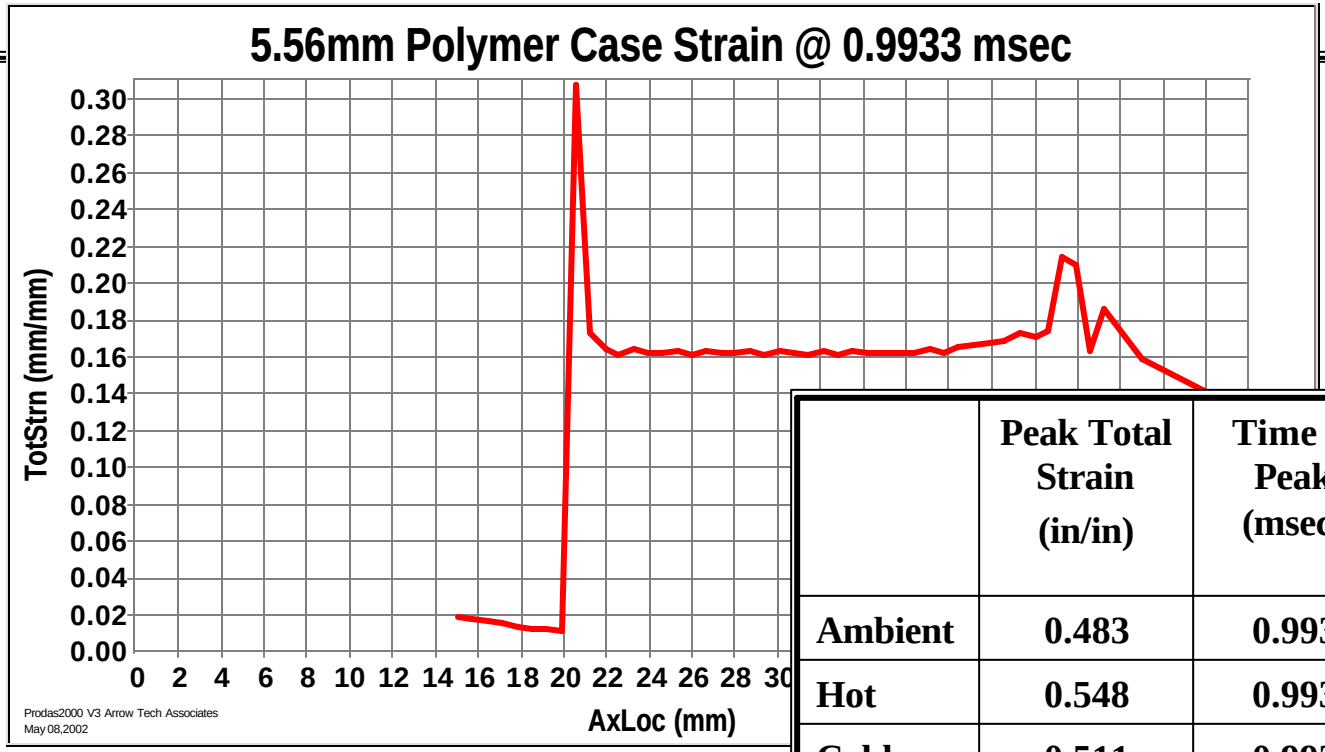
Analysis Results – Total Strain

Case/Condition	*Peak Total Plastic Strain (in/in)*	*Time at Peak (msec)*	*Elastic Strain (in/in)*	*Total Strain (in/in)*	*Percent of Ultimate Strain*
Brass-Cold	0.044	1.235	0.004	0.048	40%
Brass-Ambient	0.044	1.060	0.004	0.048	40%
Brass-Hot	0.049	1.034	0.004	0.053	44%
Polymer-Cold	0.275	1.544	0.02	0.295	52%
Polymer-Ambient	0.284	1.503	0.02	0.304	53%
Polymer-Hot	0.313	1.503	0.02	0.333	58%

Analysis Results – Dimensional Strain

Case Scenario	*Temp. Condition*	*Axial Plastic Strain (in/in)*	*Total Strain (in/in)*	*Percent of Ultimate Strain*
Min Case/Min Cham	Ambient	0.146	0.341	60%
Min Case/Max Cham	Ambient	0.258	0.477	84%
Max Case/Min Cham	Ambient	0.099	0.274	48%
Max Case/Max Cham	Ambient	0.099	0.275	48%
Min Case/Max Cham	Hot	0.273	0.529	93%
Nominal	Ambient	0.118	0.304	53%

Analysis Results – Total Plastic Strain



	Peak Total Strain (in/in)	Time of Peak (msec)	Axial Location (from base of PRODAS model) of Peak (in)
Ambient	**0.483**	**0.993**	**0.782**
Hot	**0.548**	**0.993**	**0.782**
Cold	**0.511**	**0.993**	**0.782**

At Ambient:

Total Elastic Strain (0.033) + Plastic Strain (0.483) = Total Strain (0.516)

Worst Case: Total Strain of 0.516 is approx. 90% of ultimate strain (0.57)

Analysis Results - Summary

- IB/Modeling Analysis of Amtech 5.56mm Polymer Case
  - Design Indicated as Structurally Adequate, with Peak Total Strain Yielding Sufficient Margin to Ensure Function Without Separation at All Temperature Conditions
    - At Nominal Dimension, the Amtech Polymer Case Performs at 52-58% of Ultimate Strain; Worst Case ~ 90% of Ultimate Strain
  - Less Interior Ballistic Variation over Temperature Range than Brass Case
  - Lower Total Impulse Delivered than Brass Case
  - Lower Heat Transfer to Chamber than Brass Case
  - Lower Initial Extraction Force than Brass Case
- Model Validates Demonstrated Testing Performance

Project Status - Analysis Studies

- Additional Studies
  - 7.62mm Initial Study Complete
    - Scaled Up Simulation Model Predicts Actual Testing Results
    - Design Indicated as Structurally Adequate, with Peak Total Strain Yielding Sufficient Margin to Ensure Function Without Separation at All Temperature Conditions
  - 50 cal. and Larger Calibers to be Studied as Project Progresses

Project Status – U.S. Military Testing

- Amtech 5.56mm Polymer-Cased Ammunition
  - Passed Final Pre-Qualification Screening Test Conducted for Office of Naval Research (ONR) Contract
  - Passed Safety Certification Testing Conducted by Aberdeen for USSOCOM
    - Cartridges Procured to Begin Initial User Evaluation
  - Scheduling Pre-Qualification Test for ARDEC at Picatinny Arsenal (Standard LAT + Additional Tests)
    - Successful Test Results to be Followed by Army Pre-Production Qualification Testing

NICO PYROTECHNIK
HANNS-JÜRGEN DIEDERICHS GMBH & CO. KG

REDUCING TARGET DISPERSION FOR HIGH MASS AND LOW VELOCITY PROJECTILES

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GERMANY

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Arlington, Virginia 22202

NDIA 2002 International Infantry & Small Arms Symposium
Session X - Small Arms Technology & Systems

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HANNS-JÜRGEN DIEDERICHS GMBH & CO. KG

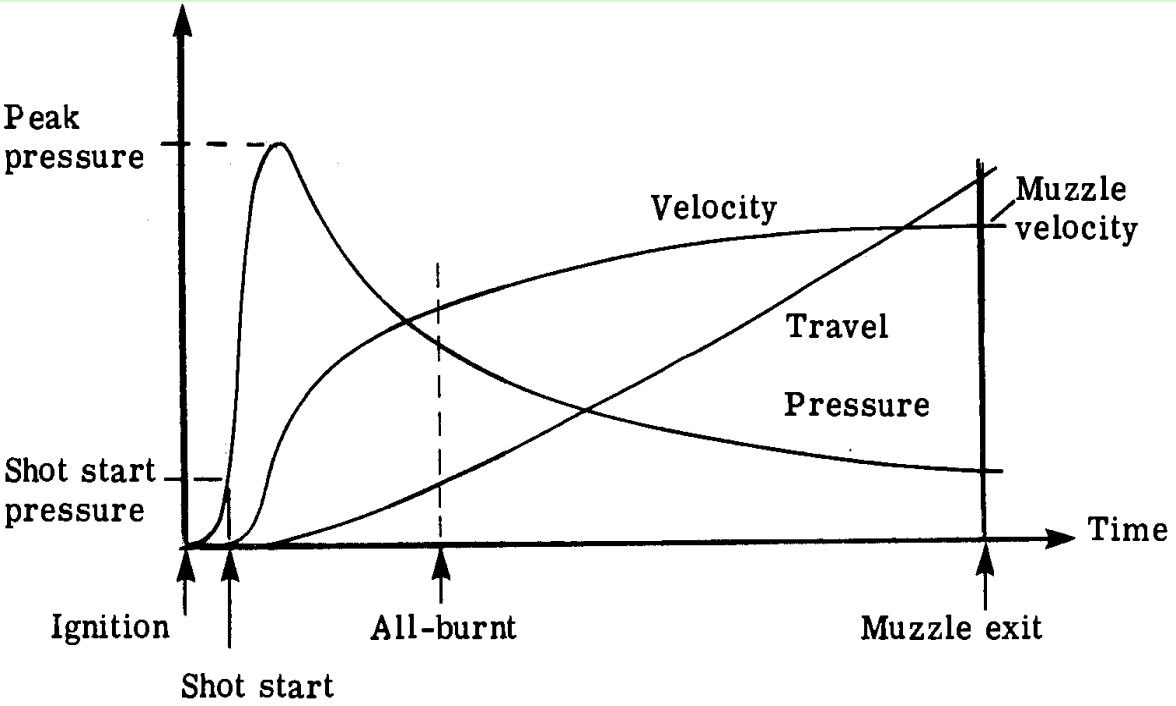
IDEAL INTERNAL BALLISTICS FOR GUN FIRED ORDNANCE

- **Modern single and double based propellants work best at high pressures to ensure complete combustion of the powder soon after the projectile moves (shot start)**

- **This ensures reproducible muzzle velocities independent of crimping force and only slightly dependent on ambient temperature**

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HANNS-JÜRGEN DIEDERICHS GMBH & CO. KG

IDEAL PRESSURE/TIME, TRAVEL/TIME & VELOCITY/TIME CURVES



The ideal system works best at high velocities and high pressures

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HANNS-JÜRGEN DIEDERICHS GMBH & CO. KG

NON-IDEAL INTERNAL BALLISTICS

- For low velocities and low pressures there is little resistance to projectile travel. The propellant burns into an increasing volume which restricts the rise in pressure and limits the increase in burning rate.

- As a consequence, not all propellant is burnt at shot exit leading to erratic muzzle velocities and high target dispersion

- In this situation, muzzle velocities and target dispersion become very dependent on ambient temperature

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PRINCIPLE OF HIGH-LOW PRESSURE PROPULSION SYSTEMS

- **Separate high and low pressure chambers are adopted in some systems such as 40mm cartridges**

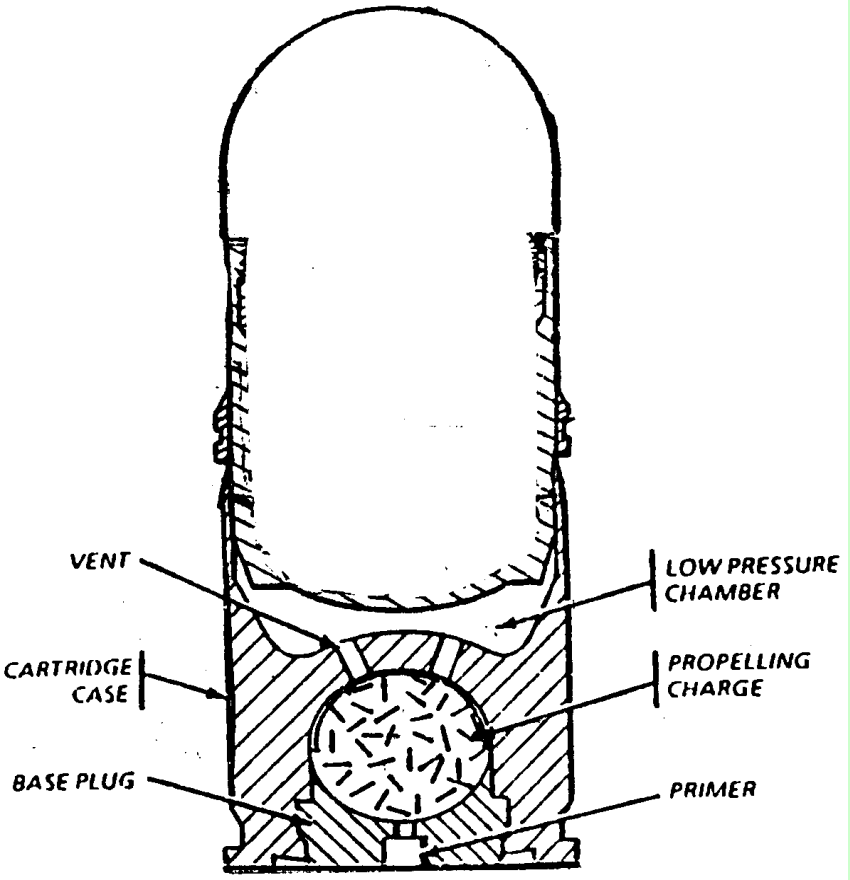
- **This ensures that the propellant burns at high pressure until a copper disc is ruptured between the high and low pressure chambers**

- **Even so, all the powder may not be burnt before shot exit, particularly at low ambient temperatures**

NICO PYROTECHNIK
HANNS-JÜRGEN DIEDERICHS GMBH & CO. KG

STANDARD US CARTRIDGE CASE DESIGN FOR 40MM HIGH VELOCITY PROJECTILES

- *M430 (HEDP)*
- *M385 (Inert Slug)*
- *M918 (Flash/Bang)*



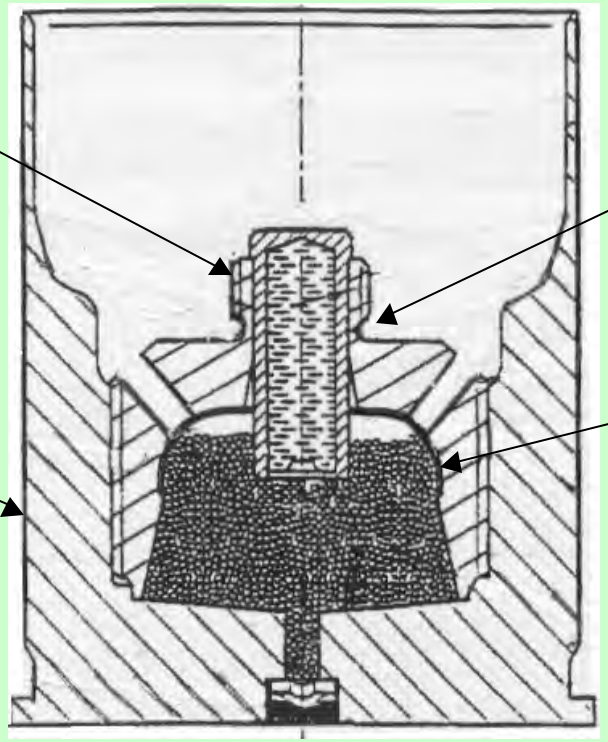
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PRINCIPLE OF NICO HIGH-LOW PRESSURE PROPULSION SYSTEM

- **The cartridge case is screwed to the projectile during assembly**
- **Shot start occurs when sufficient pressure is reached in the low pressure chamber to rupture the connection between the cartridge case and the projectile**
- **This occurs at a pre-determined break point at the base of the screw connection between the projectile and its case**

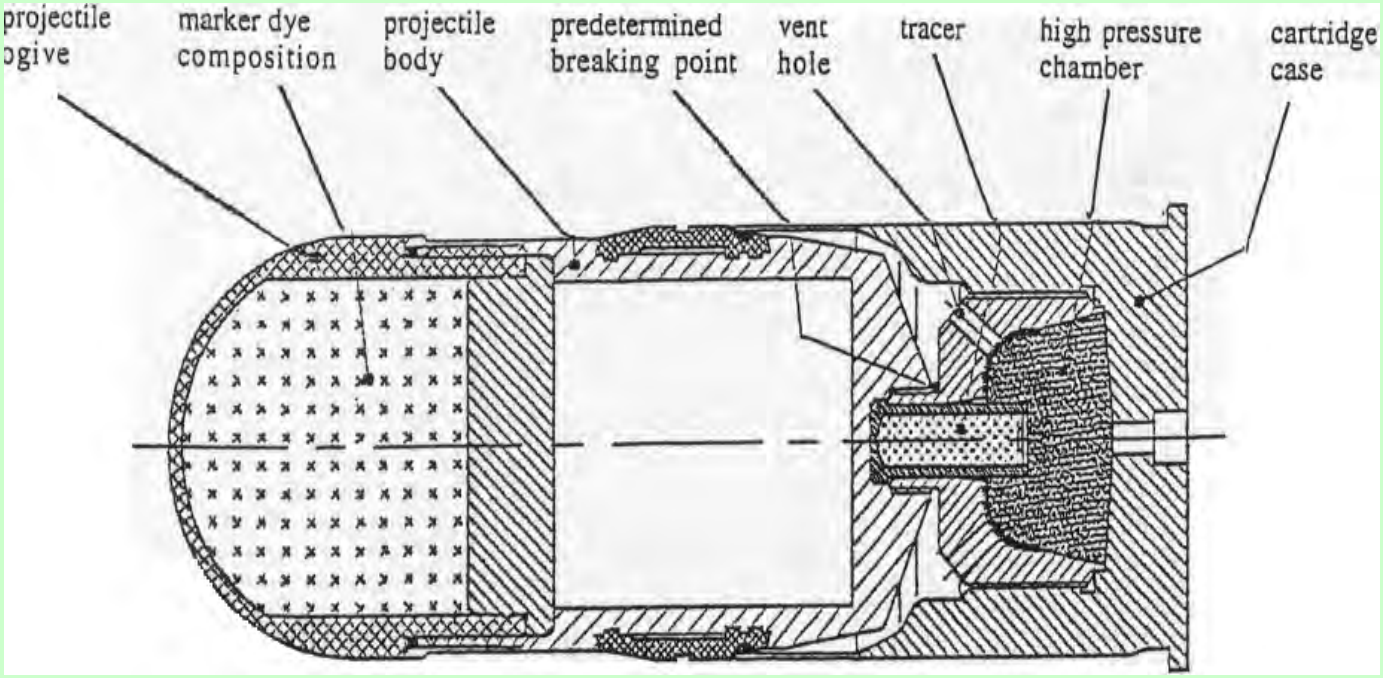
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NICO PROPUSION SYSTEM DESIGN FOR 40MM HIGH VELOCITY PROJECTILES



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HANNS-JÜRGEN DIEDERICHS GMBH & CO. KG

TYPICAL NICO CARTRIDGE FOR 40MM HIGH VELOCITY PROJECTILES



40mm x 53 Practice Cartridge with Impact Signature and Tracer

NICO PYROTECHNIK
HANNS-JÜRGEN DIEDERICHS GMBH & CO. KG

ADVANTAGES OF NICO CARTRIDGE CASE DESIGN

- **Dispersion is reduced because the propellant burns faster at the higher pressure and is all consumed before shot exit**
- **The one piece cartridge case removes the need for a separate base plug**
- **The design permits the use of a tracer**

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HANNS-JÜRGEN DIEDERICHS GMBH & CO. KG

40mm MOPI REQUIREMENT TESTING AT MEPPEN

				SD of Dispersion at 300m	SD of Dispersion at 300m
Cartridge type	Temp (C)	Vo (mps)	SD (mps)	Width (m)	Height (m)
NICO 40mm	+21	240.4	2.3	0.52	0.31
NICO 40mm	+52	241.8	2.4	0.63	0.37
NICO 40mm	-35	238.5	2.5	0.74	0.45
M430	+21	242.5	2.9	0.82	0.61
M430	+52	246.8	3.4	1.05	0.83
M430	-35	227.6	4.8	1.64	1.04

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SUMMARY

- **The NICO propulsion system design reduces projectile dispersion on the target**
- **A family of 40mm cartridges (Practice, CS, OC, Flash/Bang) has been designed around the NICO propulsion system**
- **NICO's propulsion system has been adopted in 40mm air-bursting programmable ammunition for USSOCOM's Advanced Lightweight Grenade Launcher (ALGL) program**



FRANGIBLE AMMUNITION

May 15, 2002

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Weapons Department
Ordnance Engineering Directorate
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FRANGIBLE AMMUNITION

- OBJECTIVES
- WHO USES FRANGIBLE?
- REQUIREMENTS
- NSWC, CRANE FRANGIBLE PROGRAMS
- PROBLEMS AND CONCERNS

TRAINING OBJECTIVES

Frangible ammunition should:

- Cause Minimal damage to training facility
- Eliminate lead/toxic emission around shooter
- Eliminate lead/toxic accumulation down range
- Reduce ricochet hazard

OPERATIONAL OBJECTIVES

Frangible ammunition should:

- Be lethal
- Be accurate (100Meters)
- Reduce ricochet hazards
- Reduce hard target penetration
- Be used for
  - Close Quarter Battle (CQB)
  - Military operation in Urban Terrain (MOUT)
  - Visit Board Search and Seizure
  - Counter-Narcotics (CN) Operation

WHO USES IT?

Approved users are:

- Naval Special Warfare Command (SPECWARCOM)
- Chief of Naval Education and Training (CNET)
  - RTC Great Lakes
- U. S. Air Force
- U.S. Marine Corps

WEAPONS

- 5.56mm
  - M16A2 Rifle
  - M4A1 Carbine
  - M247 SAW
  - Mk 46 Light Machine Gun
- 9mm
  - M9 Pistol
  - M11 Pistol
  - P226 Pistol
  - MP5 Sub-Machine Guns
- 45 Cal
  - M1911A Pistol
  - Mk23 Offensive Handgun

U.S. MARINE Operational Requirements Document

- U.S. Marine issued ODR for Close Quarter Battle Weapon, NO. INS. 1.14 (August 94)
  - The intent of the CQBW was to replace the MP5s Sub-machine Guns used by MEUSOC and MCSF with M4 Carbine
  - The ORD identified two rounds, two missions
    - Training
    - Operational
- Revision 20 March 1998
- The Revision identified one round, two missions

SPECWARCOM
Join Operational Requirements Document

- SPECWARCOM Finalized Joint Operational Requirements Document (JORD) (April 98)
  - Based on frangible technology and operational requirements
  - JORD was reviewed by other USSOCOM activities
- USSOCOM Approved JORD (Aug 98)
  - 3 Calibers; 5.56MM, 9MM, and .45 Caliber
- One round two missions
  - Training
  - Operational

REQUAIRED CAPABILITY

- Must be lead-free/non-toxic
- Must function weapon as reliably as current NATO Ball cartridges
- Must not penetrate background materials **(Shoot Houses)**
  - 3/8 in. AR500
- Must be waterproofed
- Must be no reverse splatter
- Must be no hazardous ricochet

REQUAIRED CAPABILITY

- Must have primer sensitivity comparable to lead based primers
- 5.56mm and 9mm/.45 cal. must meet following requirements at 100M and 50M respectively:
  - Accuracy comparable to current NATO Ball cartridge
  - Adequate lethality
  - Ballistic match for current NATO cartridge

U.S. MARINE
5.56mm Safety Certification

- NSWC, Crane conducted Performance Evaluation to determine if any commercially available cartridges could meet the ORD requirements (June 98)
  - None of the cartridge designs met all Operational Requirements
  - Winchester Ranger was Selected by USMC

U.S. MARINE
5.56mm Safety Certification

- March 1999
  - USMC Task Crane to
    - Catalog
    - Conduct Safety Certification Testing
    - Obtain WSESRB Release
- Testing Completed January 2000
- May 2000 WSESRB issued Safety Approval for release (AA40)

SPECWARCOM
Solicitation of Cartridges

- WARCOM task Crane to procure and Safety Certify 5.56MM, 9MM and .45 Caliber Frangible Ammunition (Nov 98)
  - Specifications prepared based of JORD requirements
  - Solicitation issued February 1999 (5.56MM)
    - Five Vendors responded and provided bid samples

- Evaluation of Bid Samples completed (July 99)
  - None of the samples met all the performance requirements
  - Acceptable function & casualty, lethality, accuracy, ballistic match
  - Deficiencies:
    - Over penetration on hard target
    - Primer sensitivity
    - Waterproof
- Specification modified

- Reissued solicitation (Dec 99)
  - Dropped lead-free primer requirement
  - Emphasized accuracy, lethality and no backstop penetration (AR500 Steel Plate)
  - Two previous vendors responded w/bid samples

SPECWARCOM
5.56mm Safety Certification

- Conducted 2nd bid sample evaluations (Mar 00)
  - Neither vendor's samples met all performance requirements
  - Deficiencies:
    - Over penetration on hard target
    - Accuracy
    - Waterproof
    - Function and Casualty
- Based on test results WARCOM suspended action Pending development of R^2LP cartridge (April 00)

SPECWARCOM
9mm and .45 Cal. Solicitation

- Solicitation for 9mm and Caliber .45 issued (May 99)
  - Five Vendors responded for 9MM
  - Four Vendors responded for .45 Caliber

SPECWARCOM
9mm and .45 Cal. Safety Certification

- Evaluation of Bid Samples completed (Jan 00)
  - None of vendors met all of the requirements
  - Deficiencies:
    - Function & Reliability
    - Over penetration on Drywall
    - Primer sensitivity
    - Waterproofing
- SPECWARCOM dropped requirement

CNET
9mm Safety Certification

- NSWC Crane tasked by Chief Naval Education & Training (CNET) to obtain WSESRB release for 9MM Frangible Ammunition (Mar 00)
  - Handgun Marksmanship Training @ RTC Great Lakes
- Cartridge Salient Characteristics
  - Lead Free/Non-Toxic
  - Function Beretta M9 Pistol
  - Reduced ricochet/Penetration
- It was determined that the CNET requirements were within the WARCOM JORD

CNET
9mm Safety Certification

- Minimal additional testing was required
  - Function and Casualty
  - AR500 Steel Plate Penetration
  - Ricochet
- SNC cartridge configuration best conformed to specification requirements
- Received JAG approval for training use by CNET (June 00)
- WSESRB issued safety approval (July 00)
  - AA16

USAF
9mm Safety Certification

- NSWC Crane tasked by USAF Security Force to Procure AA16, 9mm Frangible Ammunition (Jan 02)
  - Weapon qualification and proficiency Training
- Cartridge Salient Characteristics
  - Lead Free/Non-Toxic
  - Function Beretta M9 Pistol
  - Reduced ricochet/Penetration
- AA16, 9mm Frangible Ammunition is approved by Non-Nuclear Munitions Safety Board

SPECWARCOM
5.56mm Frangible Requirement

- WARCOM identified a requirement for 5.56MM Frangible ammunition for training (Mar 2001)
  - For CONUS and OCONUS use
  - This requirement to fill training requirements until the R^2LP Cartridge is fully developed
- JAG approved 5.56mm frangible cartridge for training use only, CONUS/OCONUS (May 01)
- WSESRB issued safety approval for CQB and Indoor Training (Sept 01)
- WSESRB extended approval to use outdoors (Jan 02)

SPECWARCOM
9mm Frangible Requirement

- WARCOM identified a requirement for AA16, 9mm Frangible Ammunition for training
  - CONUS
  - OCONUS
  - For use in Sig Sauer P226, P228 and H&K MP5 Sub-Machineguns
- Received JAG approval for training use only by WARCOM units and CNET (Feb 02)
- Received WSESRB safety approval (Feb 02)

PROBLEMS & CONCERNS

- No-lead primer not meeting military operational requirements at extreme temperatures
- Need improved waterproofing
- Over-penetration on hard targets
- Over-penetration on soft targets (9mm)
- High Failure Rate of 9mm in MP5s

R^2LP

- Reduced Ricochet, Limited Penetration (R^2LP) Cartridge is being developed to meet current frangible ammunition requirements.

INDIVIDUAL
PROTECTION

Advanced Soldier Ballistic Protection

2002 International Infantry Conference

15 May 2002

Mr. Robert F. Kinney
(508) 233-4308; DSN: 256-4308
Email: robert.kinney@natick.army.mil



DIRECTORATE

Current Ballistic Protection

•*Interceptor & Small Arms Protective Insert*



Vest: 7.8-8.4 lb, Torso coverage
Protects against:
Conventional frag, handgun
SAPI: 4 lb
Conventional ball rounds



•*Full Spectrum Battle Equipment (FSBE)*

Reduced **area of coverage**
SAPI



•*BALCS*

Vest: 6.5 lb
Level IV Plate: 6 lb

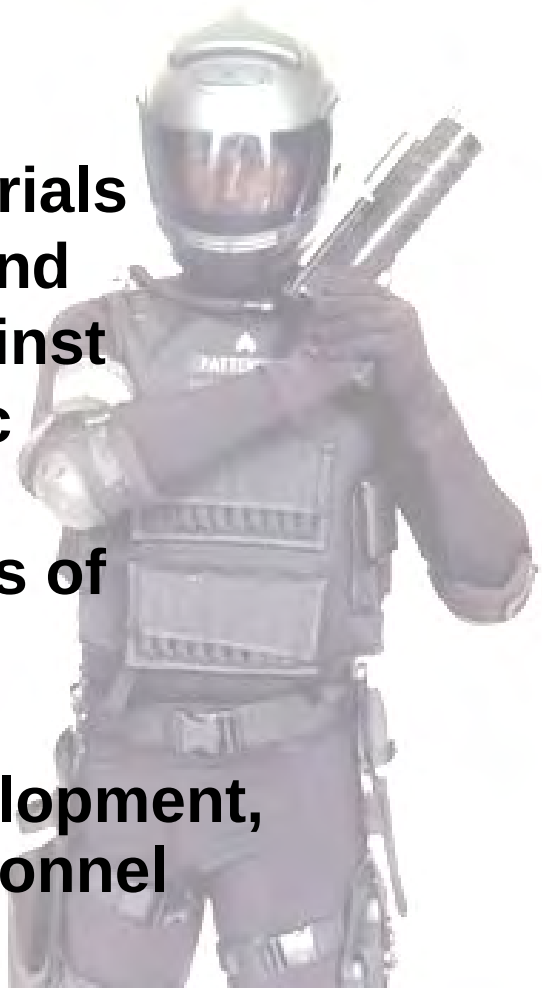


•*Standard PASGT*
•*Modular/Integrated Communications Helmet (MICH)*
•*Lightweight Helmet*

Helmet : 3 lb
Protects against conventional frag, 9mm
Improved Suspension system

Advanced Soldier Ballistic Protection

Objectives



. . . **Develop/insert advances in materials technology to *improve protection* and performance of armor systems against conventional and emerging ballistic threats while *minimizing penalties* associated with the increased levels of protection.**

. . . ***Provide tools*** **to benefit the development, design, test and acquisition of personnel armor.**

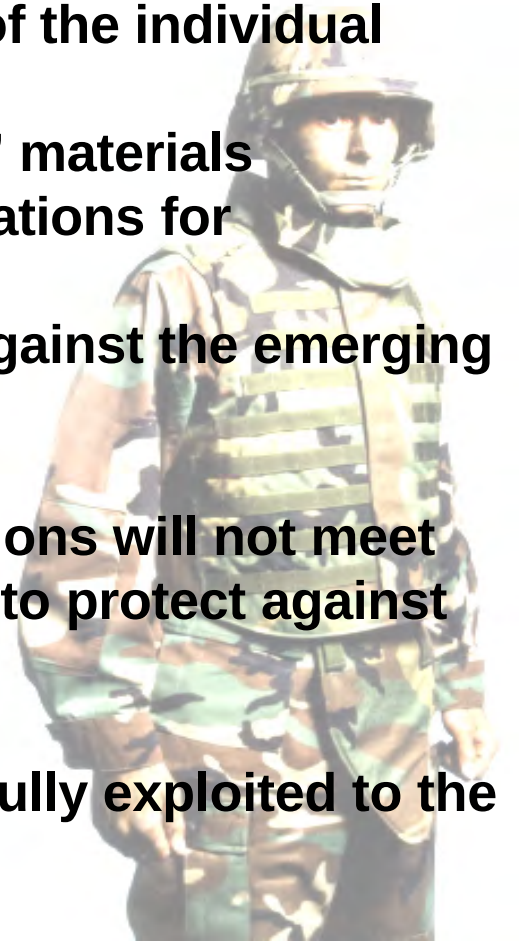
Advanced Soldier Ballistic Protection

Why do this work?

- **Armor is a significant contributor to the load of the individual warfighter.**
  - **Today's armor employs "state-of-the-art" materials (ceramics/textiles) in traditional configurations for conventional threat protection.**
  - **Minimal protection is presently offered against the emerging threats.**

- **Current state-of-the-art technology configurations will not meet future personnel armor systems weight goals to protect against conventional or emerging ballistic threats.**

- **Existing materials technology have not been fully exploited to the optimal performance levels.**



Advanced Soldier Ballistic Protection

Why do this work?

- **Current methodology(s) for assessing the behind armor effects of non-penetrating impacts onto body armor (helmet and vests) tend to assess the mechanical performance of the armor system.**

- **Standards to assess "blunt trauma" that are presently employed have a limited biomechanical foundation**

- **Current casualty reduction assessments are performed using models such as CASRED or Full Spray Lethal Area that are limited due to:**

  -Lack of flexibility to represent multiple fragment materials (e.g., steel, tungsten)
  -Poor representation of human targets and body armor coverage
  -Limited representation of fragment penetration algorithms
  -No capability to easily change algorithm parameters
  -Lack of adequate representation of casualty effects

Advanced Soldier Ballistic Protection

Payoffs

- **Light weight personnel armor with significant increase in ballistic protection - Depending on threat - up to a 40% reduction in ballistic materials weight over start point of this DTO**
- **Better protection and lighter weight equates to improved survivability and tactical mobility for the individual**
- **Enhanced analytical tools for body armor development, test and evaluation and acquisition/ fielding**
- **More realistic survivability assessment**

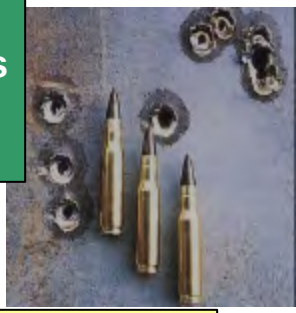
Advanced Soldier Ballistic Protection

Conventional Threats
Steel Fragments
Small Arms Bullets –
Lead and Steel Cored

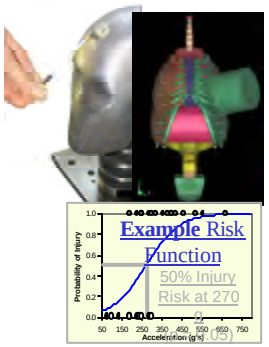




Emerging Threats
Low Mass, High Density Fragments
Small Arms Bullets –
Tungsten Carbide Cored



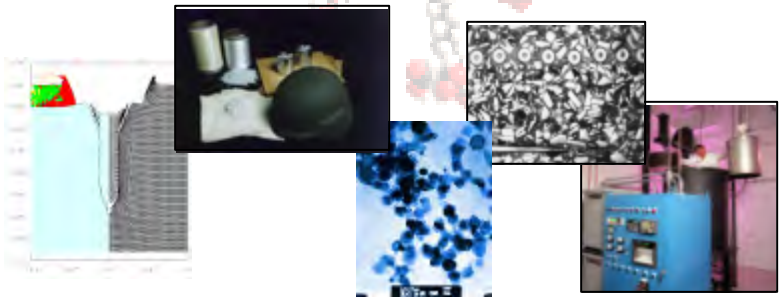
Behind Armor Effects Methodology



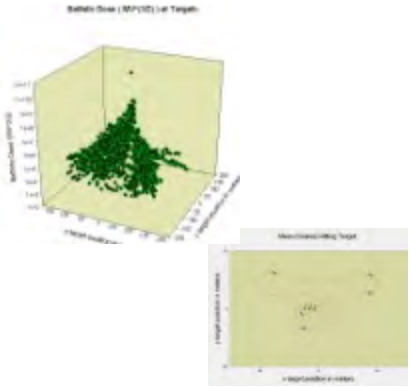
Conduct experimental (tissue & test fixture), analytical and numerical assessments of non-penetrating impact on body armor/body

Advanced Technology Development

- New high performance polymers/ fibers/composites
- Nanotechnology
- Advanced ceramics & metals
- Enhanced predictive modeling
- Material systems integration



Casualty Reduction Analysis Model



Develop/update models for armor system performance from threat definition to incapacitation effect

Advanced Soldier Ballistic Protection

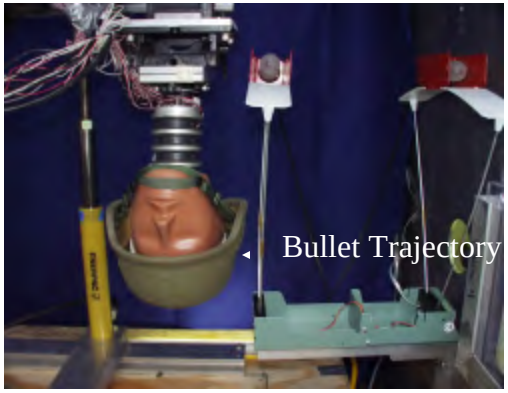
Behind Armor Effects - Helmet Assessment Methodology

- Objective, dynamic biomechanical test method for accurately determining skull fracture potential of non-penetrating ballistic impacts on helmets.
- Human Impact Location
  - Temporoparietal Bone
  - Near the Lambdoidal Suture
  - Above the Frankfort Plane

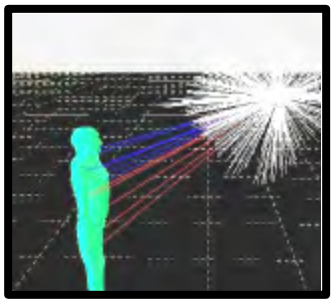
First objective method
In the world
based on biomechanics



- Validated through mechanical and cadaveric experimentation
- Established a risk of injury (fracture) curve for 9mm impacts on the helmet at various velocities



Advanced Soldier Ballistic Protection



Integrated Casualty Estimation Methodology

Key Accomplishments:

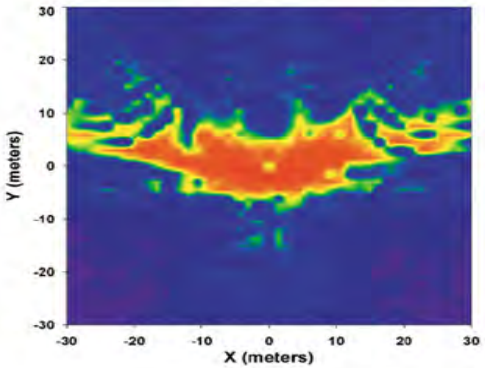
- **Implemented Interface with Operational Requirement-based Casualty Assessment (ORCA) Library Functions**
- **Implemented Cunniff Equations For Ballistic Penetration**
- **Implemented Improved Representation of Munition Arena Test Data**
- **ICEM website, codes, and user's manual, available on-site, for authorized users**

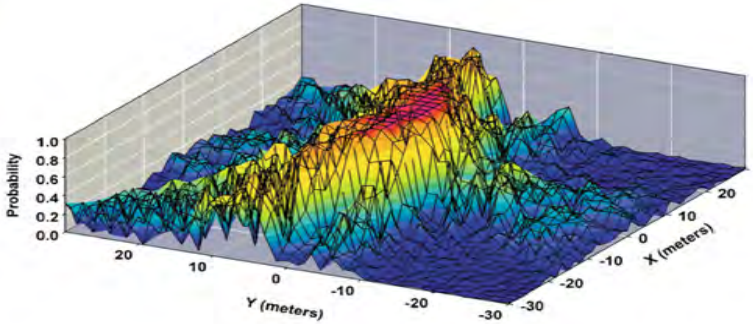
ICEM Version 1.0 Scheduled for Release in Mar 02

http://www. stiusa.com/ icem

Integrated Casualty Estimation Methodology



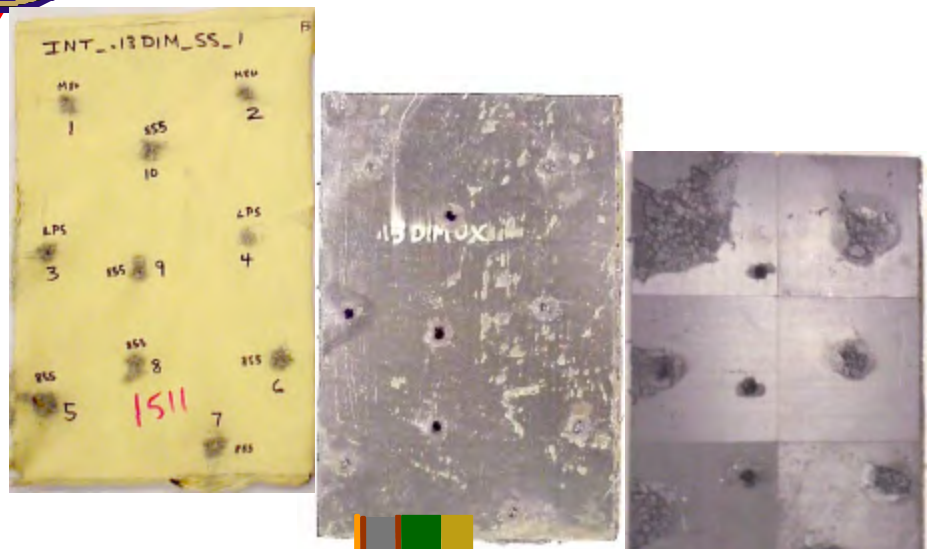


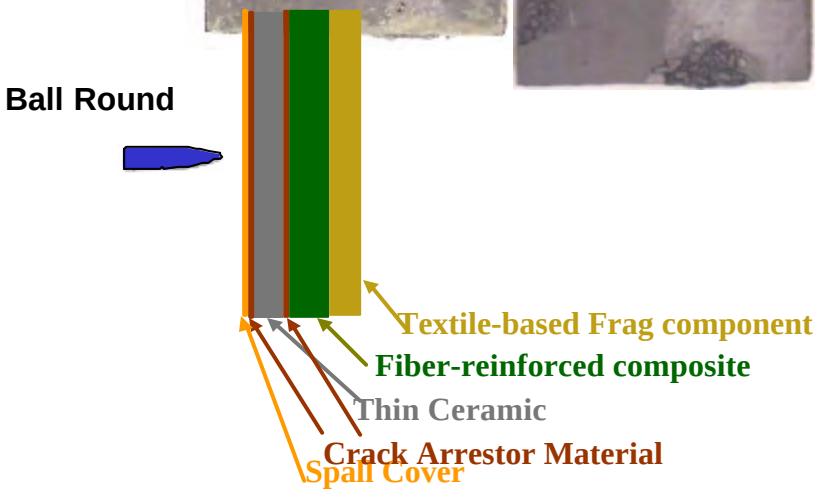




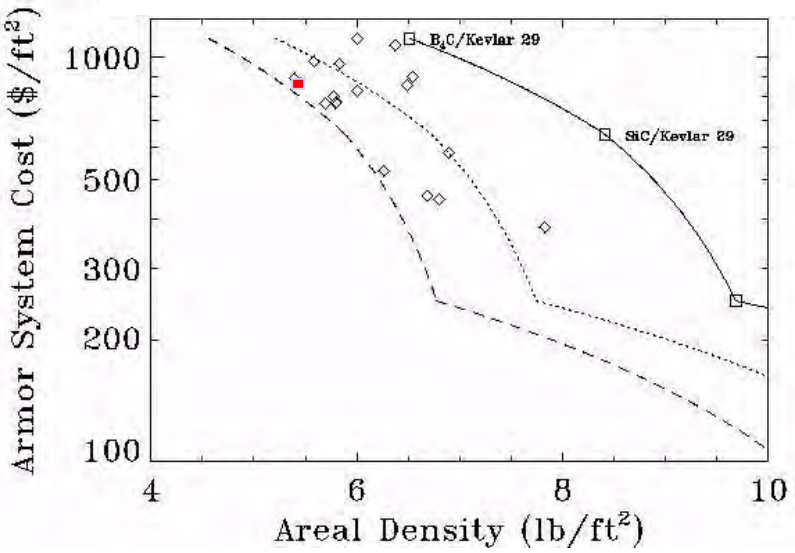
Probability Of Incapacitation

Advanced Soldier Ballistic Protection



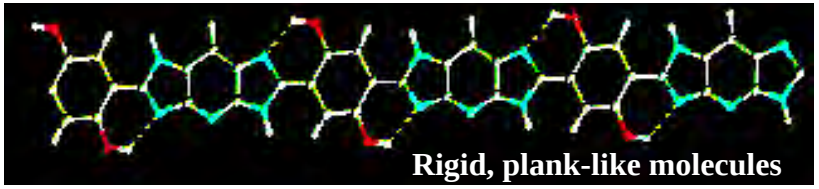


- Increasing state-of-the-art materials performance through improved composite architectures

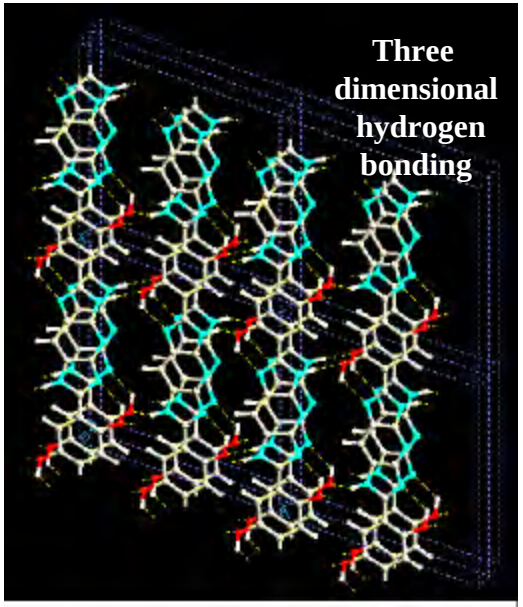


Advanced Soldier Ballistic Protection

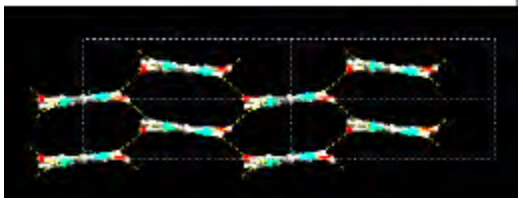
M5 - New Fiber Technology



- M5 fiber is a new high performance experimental fiber.



- M5 has extraordinary potential for use in armor systems for personnel and vehicles, flame and thermal protection, as well as high performance textiles.
- Current production of the fiber is at the bench scale using a batch process.
- Fiber properties are less than optimal under current processing conditions.
- Research ongoing to bring material properties to full potential
- Current business plan has full scale production occurring in the US (North Carolina State University)



Ballistic Protection for Improved Individual Survivability





University of Rhode Island







Walter Reed Army Institute of Research











dstl



Leveraging / Interactions





























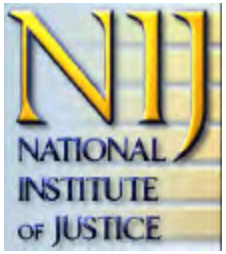








Armed Forces Institute of Pathology













BACKUP

Advanced Soldier Ballistic Protection

BEHIND ARMOR EFFECTS TECHNICAL PROGRESS :

- **Established closer cooperative tie with Medical Research and Development community**
- **Established objective, dynamic biomechanical test method for accurately determining skull fracture potential of non-penetrating ballistic impacts on helmets. Validated through mechanical and cadaveric experimentation**
- **Established a risk of injury (fracture) curve for 9mm impacts on the helmet at various velocities, confirmed performance of current Army combat helmet (no skull fracture against non-penetrating 9mm)**
- **Substantiated low risk for neck injury due to non-penetrating high velocity 9 mm impact to helmet**
- **Transferred results of Army Head Injury Criteria to Army, Navy and USMC combat helmet developers.**
- **Conducted preliminary investigations of armor (vest/plates) on UK thoracic rig**
- **Established research methodology and instrumentation requirements for accomplishing an objective, dynamic, biomechanical test method for accurately determining blunt trauma limiting effects due to non-penetrating, high velocity, impacts on torso body armor**

Advanced Soldier Ballistic Protection

MODELLING TECHNICAL PROGRESS

- Completed Beta version of Monte Carlo assessment of ballistic insults and estimation of casualties with new Integrated Casualty Estimation Methodology (ICEM) model,
- Established ICEM website, codes, and user's manual, available on-site, for authorized users
- Started preliminary validation and verification (V&V) for ICEM Version 1.0
- Designed and manufactured selected glass/plastic and plastic/plastic configurations at areal densities ranging from 2.5 lb/ft^2 - 5 lb/ft^2 to establish performance profile against various threats (frag/9mm handgun), testing in progress
- Continued characterization of high strain rate mechanical properties of textile fabrics for use in analytical and hydrocode models

Advanced Soldier Ballistic Protection

MATERIALS TECHNICAL PROGRESS

- Transferred technology for 1st generation small arms (ball) protection; established new baseline (5.2 lb/ft^2) for 2nd generation 25% reduction in weight
- Demonstrated technology for 35% reduction in countermine system
- Identified and evaluated new fibers with potential to meet out-year milestones
- Identified mechanism to enhance transparent armor through modification of ductile to brittle transition for polycarbonate/polymethyl methacrylate

Advanced Soldier Ballistic Protection

MATERIALS TECHNICAL PROGRESS

- Completed characterization of emerging bullet threat mechanical properties and failure characteristics, established baseline areal density (10 lb/ft^2 for M993)
- Identified material phase change in baseline boron carbide (B_4C) ceramic against emerging threat which reduces performance of this ceramic, began investigation of alternate ceramics
- Conducted ballistic evaluations on early novel defeat concepts for emerging bullet threats providing insight in potential path forward
- Investigated the effect of processing pressure on mechanical properties and ballistic performance of ultrahigh molecular weight polyethylene composites with varying resin systems for 2nd generation ball protection, selected optimal candidate (s) for material integration evaluation with ceramics

Advanced Soldier Ballistic Protection

MATERIALS TECHNICAL PROGRESS

- Completed initial V_{50} evaluation of improved flat- panel laminated Zylon™ composite for fragmentation protection, demonstrated performance within 10% of FY03 objective. Environmental, flexural rigidity, transient deformation and ballistic performance of helmet shapes under evaluation
- Completed initial evaluation of improved flexible fabric armor systems. Demonstrated performance approaching goal performance. Results Classified. Environmental evaluations, cost reduction studies, and enhanced fabric architecture studies ongoing.
- Identified and started exploitation of new experimental high performance fiber, M5™ from Magellen Systems International. Fiber is being produced at bench scale with properties 1.5-2 times those of commercially available ballistic fibers. Potential for 3 times strength of Kevlar™. Working with company to bring to large scale production and commercial product. Current company plan is for production in the US

NAVSEA
CRANE
Surface Warfare Center Division

Advanced Lightweight Grenade Launcher (ALGL)

Program Overview



by: Dennis Lambrecht, ALGL Program Manager, NSWC Crane
Jarl Eirik Straume, Nammo Program Manager
Jeff Gramse, GDAS Program Manager

Distribution Statement A - "Approved for public release; distribution unlimited."

ALGL Program Structure

NAVSEA
CRANE
Surface Warfare Center Division







NAVSEA
CRANE
Surface Warfare Center Division

GENERAL DYNAMICS
Armament Systems

GENERAL DYNAMICS
Canada

Nammo
NORDIC AMMUNITION COMPANY

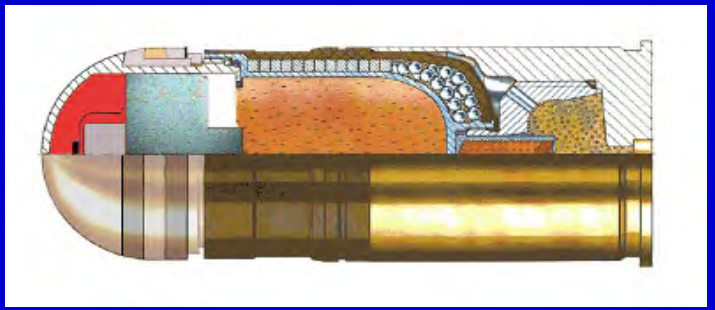
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Surface Warfare Center Division

ALGL System







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CRANE
Surface Warfare Center Division

ALGL Program Objectives

- United States Special Operations Command:
  - Field an improved 40mm weapon system meeting Special Operations Forces (SOF) requirements
- Marine Corps Warfighting Laboratory:
  - Conduct a Concept Based Experimentation Program
- Foreign Comparative Test (FCT):
  - Type Classify / Type Qualify PPHE for USSOCOM

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Surface Warfare Center Division

USSOCOM Key Requirements

- Key Performance Requirements
  - Low System Weight
  - Maximum Effective Range
  - High Probability of Hit
  - Ground and Vehicle Mounted
  - Fire Control Provides Ballistic Solution
  - Enhanced Target Detection and Recognition
  - Uses Standard and Air-Burst Ammunition

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MCWL ALGL Experiments





Mobility and Lethality:

- MK47 MOD 0 Machine Gun increased offensive capability
- ALGL fire control capability
- PPHE ammunition capability

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Surface Warfare Center Division

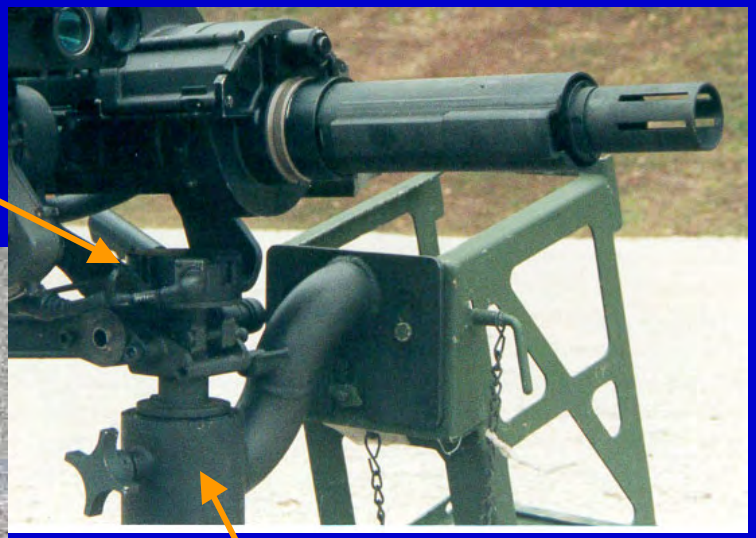
ALGL System Components

MARK 47 MOD 0 Machine Gun

Fire Control

Mount





Vehicle Adapter

Ground Tripod

PPHE Air-burst Ammunition



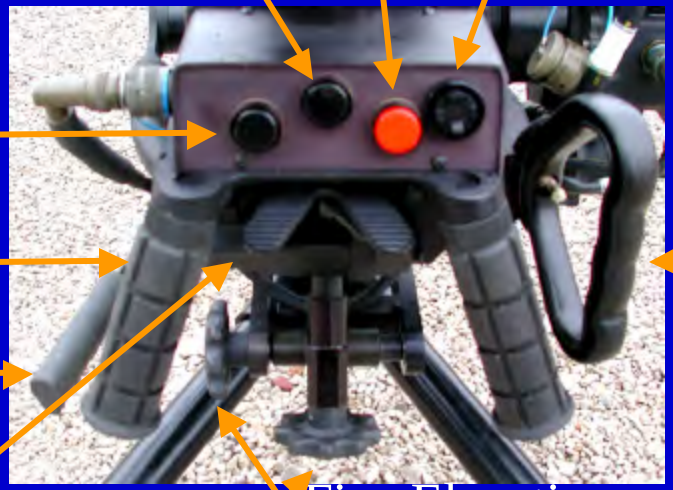
Standard Ammunition

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MK47 MOD 0 Machine Gun

- Ergonomic Improvements
- Contacts in Chamber Set Air-burst Fuze
- Operator Controls





Distribution Statement A - "Approved for public release; distribution unlimited."

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CRANE
Surface Warfare Center Division

ALGL Fire Control

- Lightweight Video Sight Fire Control

Display

Imaging / Ballistics

Brake/Super-Elevation



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CRANE
Surface Warfare Center Division

ALGL Fire Control

- Fire Control Imaging/Ballistics
  - Laser Range Finder
  - Video Image Processing
  - Night Vision
  - Ballistic Computer
  - Sets PPHE Air-burst Fuze
- Brake/Super-Elevation
  - Implement Ballistics Solution
  - Locks Weapon and Fire Control Together

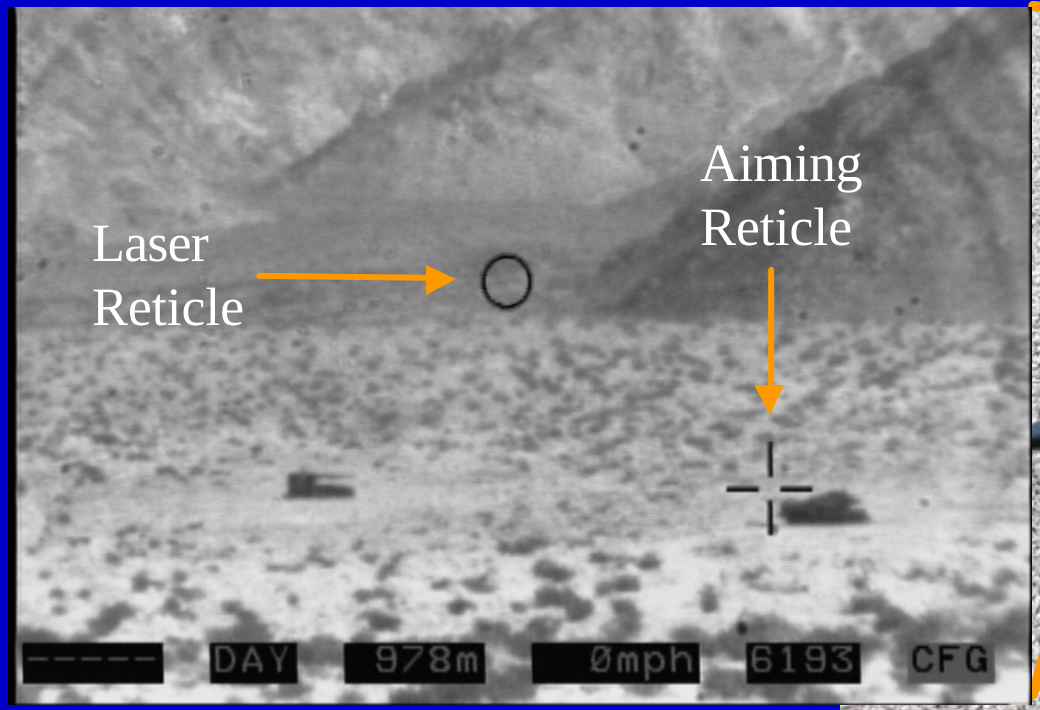


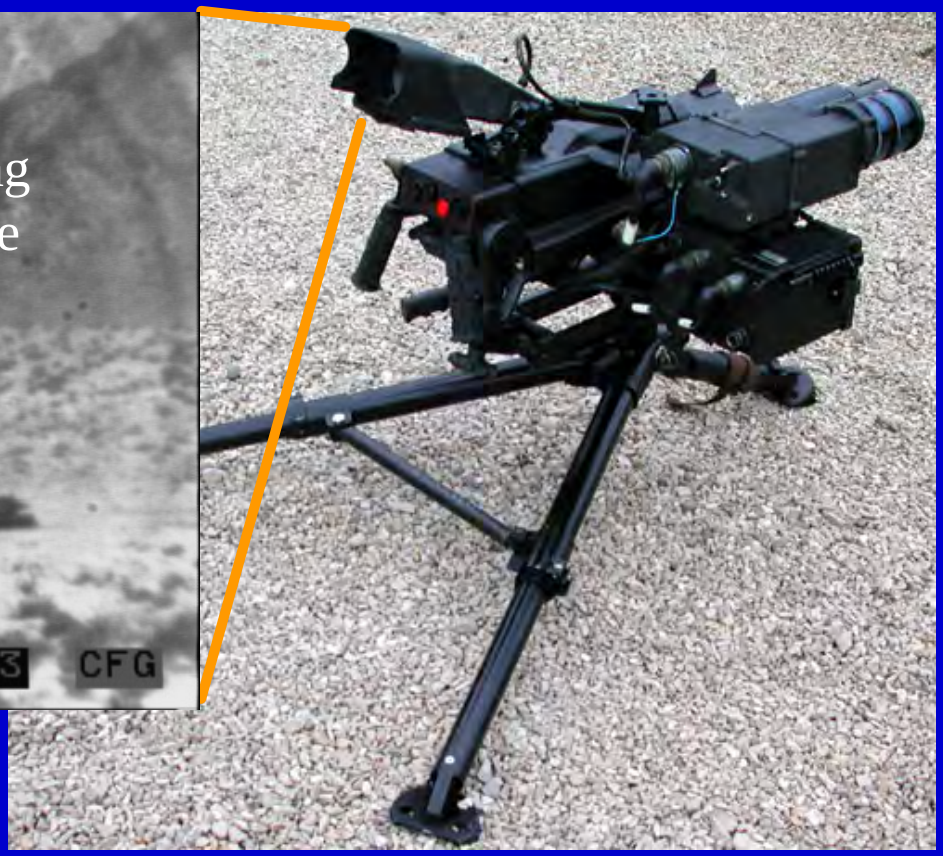
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ALGL Fire Control

Aiming Reticles for Laser and Weapon





Graphical User Interface

operator adjustments, pre-designated targets, electronic range card

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ALGL Mountings

- Mount
  - interface for weapon, fire control
  - quick slew traverse and elevation
- Lightweight Ground Tripod
- Vehicle Adapter Kit



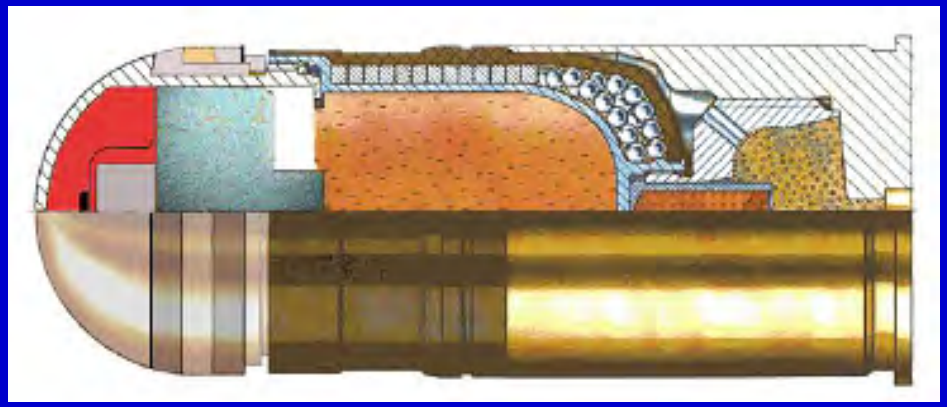


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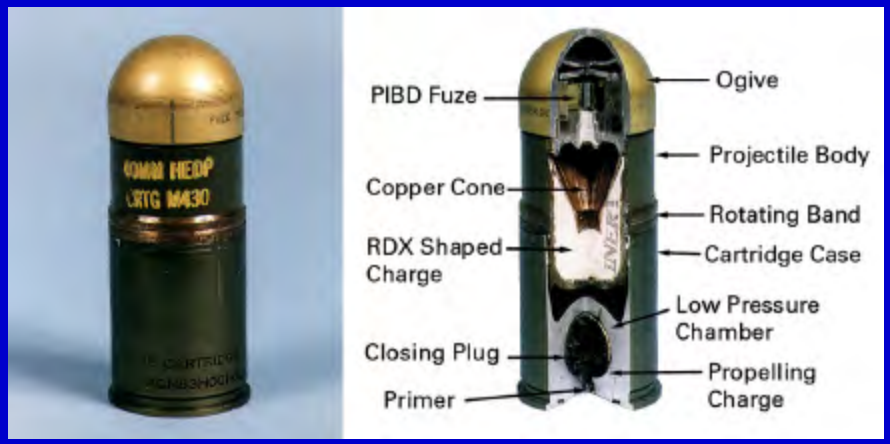
NAVSEA
CRANE
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ALGL Ammunition

- PPHE ammunition
  - air burst capability



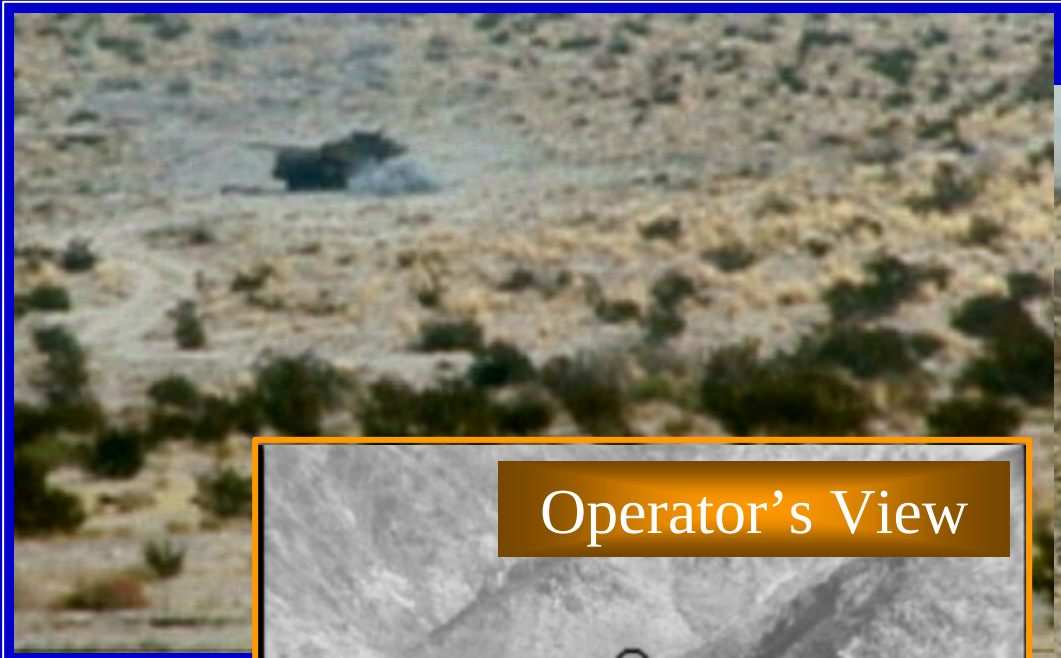
- Standard 40mm ammunition
  - M430 HEDP
  - M383 HE
  - M918 TP
  - M385 TP



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NAVSEA
CRANE
Surface Warfare Center Division

ALGL System







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NAVSEA
CRANE
Surface Warfare Center Division

ALGL Schedule

	System	Ammo
Milestone B	2Q / 01	1Q / 01
Developmental Testing	3Q / 02	1Q / 03
Operational Assessment	3Q / 02	
Safety Confirmation	4Q / 02	2Q / 03
System Prod. Certification	4Q / 02	
Milestone C / FRP	4Q / 02	4Q / 03
First Unit Equipped	2Q / 04	4Q / 04

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Surface Warfare Center Division

Developmental Testing







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CRANE
Surface Warfare Center Division

DT Summary

- Reliability
- Ballistics – firing tables and jump tests
- Platforms – hard stand, ground mount, earth box, vehicle
- Ammunition compatibility
- Adverse Environment
  - Hot, Cold, Icing
  - Salt fog
  - Mud – wet and dry
  - Sand/Dust – static and dynamic



Distribution Statement A - "Approved for public release; distribution unlimited."

NAVSEA
CRANE
Surface Warfare Center Division

System Safety

- DTC Safety Release
  - Amendment 1, 19 November 2001
- Safety Confirmation
- WSESRB Introduction



Distribution Statement A - "Approved for public release; distribution unlimited."

NAVSEA
CRANE
Surface Warfare Center Division

Operational Assessment

- OA
  - 3 ALGLs
  - NAG
  - ATC
  - May 2002



Distribution Statement A - "Approved for public release; distribution unlimited."

NAMMO & GDAS Presentations



GENERAL DYNAMICS Armament Systems

GENERAL DYNAMICS Canada

Nammo NORDIC AMMUNITION COMPANY

Distribution Statement A - "Approved for public release; distribution unlimited."



TACOM

Lethality, Survivability, Mobility and Sustainment for America's Army

FLAMELESS TRACER & MARKER

2002 International Infantry & Small Arms Symposium

15 May 2002
Atlantic City, NJ

Mark S. Leng, Stew Gilman, Leon Manole
Close Combat Armament Center

AGENDA

- INTRODUCTION
- BACKGROUND
- TECHNOLOGY BENEFITS
- Modified M781 40mm TEST FIRINGS at TACOM–ARDEC
- QUESTIONS

INTRODUCTION

- WHAT'S A TRACER ?
  - PYROTECHNIC MATERIAL (HEAVY METALS)
  - INITIATED UPON WEAPON FIRING
  - BRIGHT BURNING, TRAVELS WITH PROJECTILE
  - WEAPON CORRECTION
  - CAN START RANGE FIRES…..

- AMMUNITION FIRES
  - DANGEROUS
  - SMOKE IN SURROUNDING COMMUNITY
  - LOST TIME
  - COST TO EXTINGUISH

BACKGROUND

- 1998 RESEARCH BEGAN UTILIZING VARIOUS ARDEC FUNDING SOURCES.
- PERFORMED PRELIMINARY TANK AMMUNITION TESTING.
- PATENT DISCLOSURE SUBMITTED.
- DEMONSTRATED M781 40mm GRENADE CAPABILITY.
- DEVELOPING TRACERS & MARKERS for MULTIPLE CALIBER AMMUNITION & VARIOUS MISSIONS.
- PROVIDING DEMONSTRATIONS to the USER COMMUNITY.

TECHNOLOGY BENEFITS

- TRAINING BENEFITS
  - ELIMINATES TRACER FIRES.
  - ENVIRONMENTALLY FRIENDLY.
  - SIMULATES FLASH of EXPLOSIVE.
  - ALLOWS MODIFIED M781 to be USED AT NIGHT & DAY.
  - COST EFFECTIVE TO IMPLEMENT.
- TACTICAL BENEFITS
  - SIGNALING & IDENTIFICATION CAPABILITY.
  - INFRARED & VISIBLE LIGHT CAPABILITY.
  - ECONOMICAL

40mm M781 TEST FIRINGS

- DEMONSTRATED IR & VISIBLE TRACE MARK CAPABILITY with OVER 90 SUCCESSFUL FIRINGS in ARDEC ARMAMENT TECHNOLOGY FACILITY, OUTDOOR RANGE & FT BENNING.

- DEMONSTRATED TECHNOLOGY to PM, NATIONAL GUARD, INFANTRY SCHOOL, & OTHER USERS.

- SUCCESSFULLY ADVANCING PRESENT TECHNOLOGY to MEET USER NEEDS.

FLAMELESS TRACER

APPLIED to the 40mm M781 PRACTICE GRENADE



FIG 1. 40mm PROJECTILE WITH TRACER & MARKER CAPABILITY



FIG 2. ATF- 300M RANGE NORMAL LIGHTING



FIG 3. PROJECTILE IMPACTING CEILING

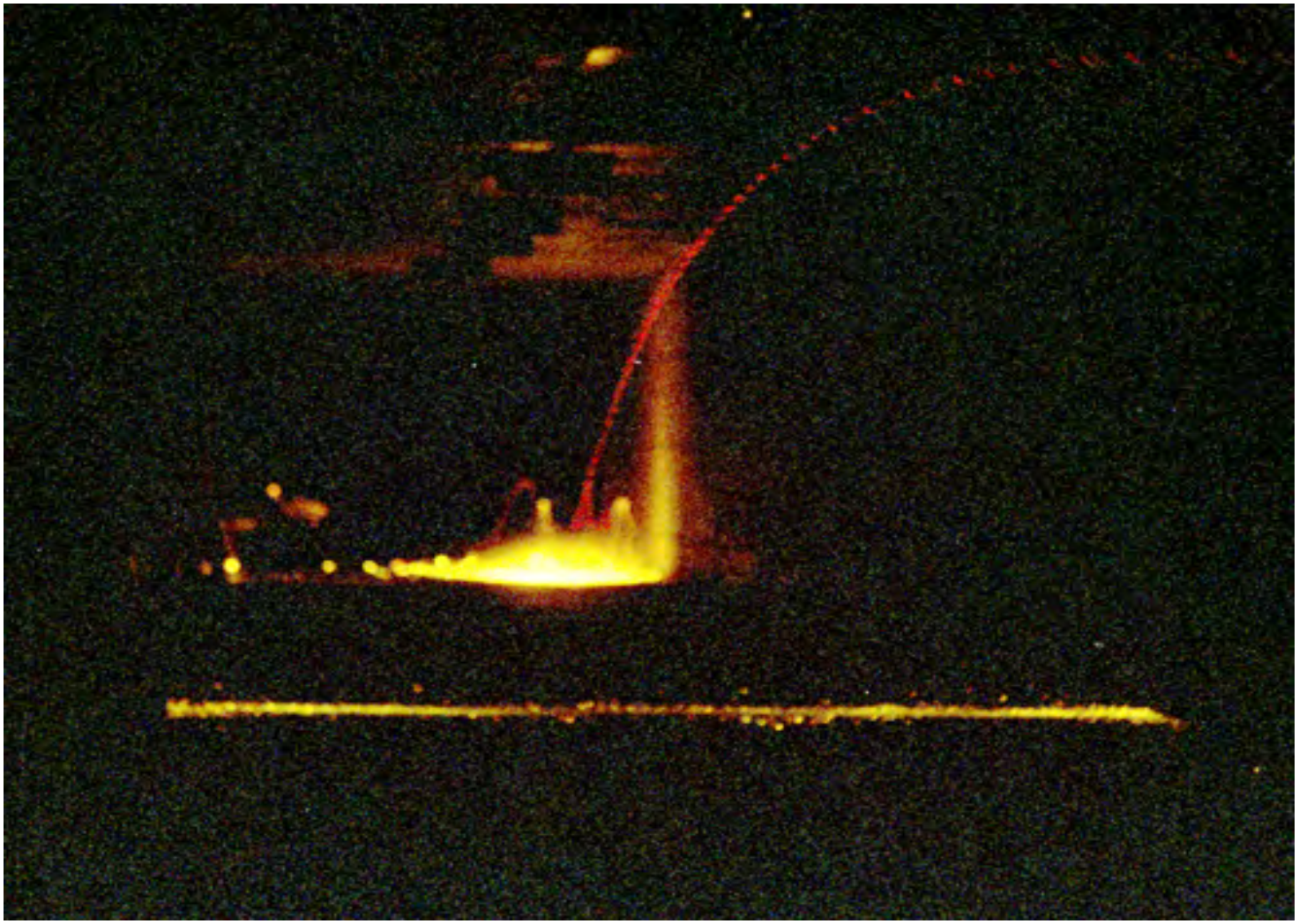


FIG. 4 40mm PROJECTILE with TRACE, IMPACTS FLOOR LEAVES MARK

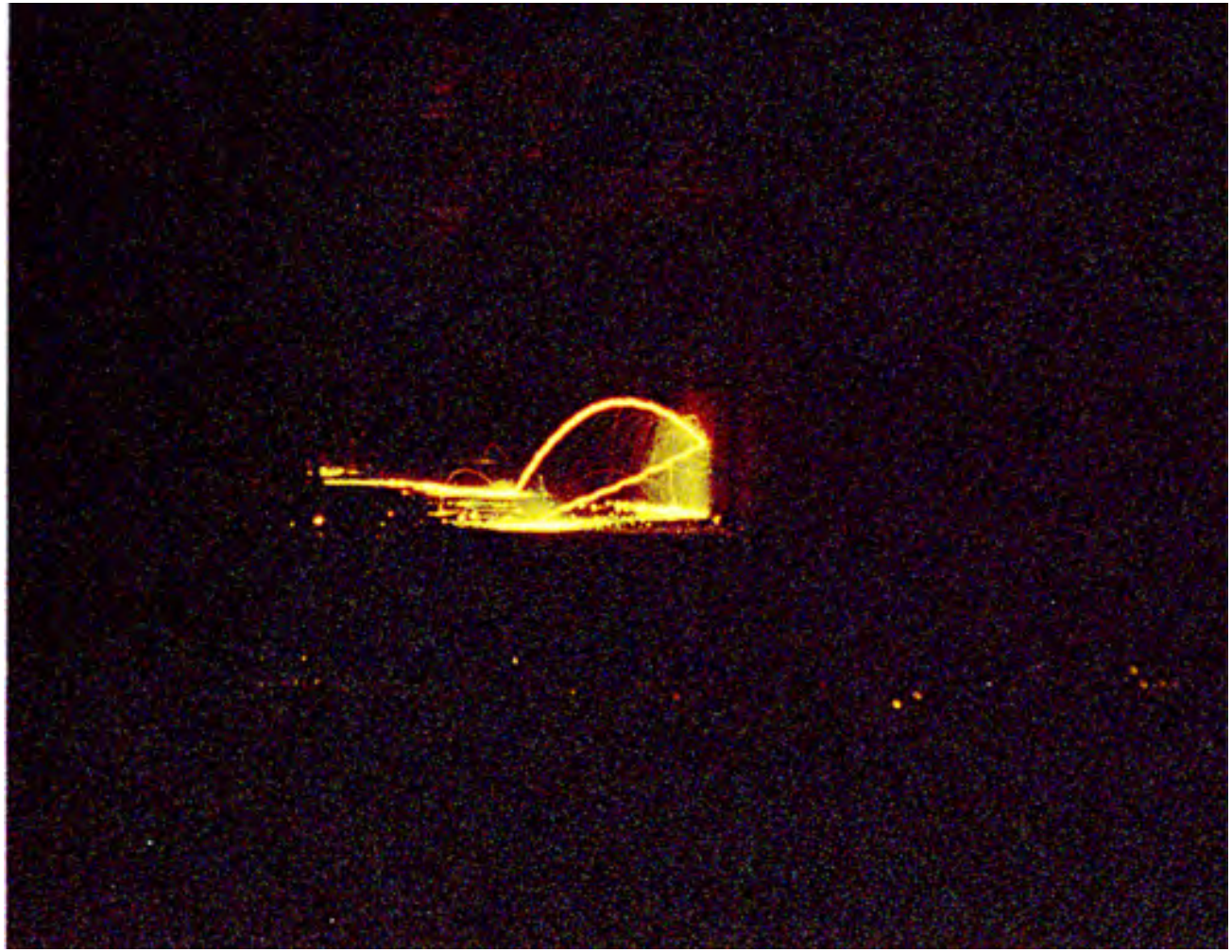


FIG 5. MARKER (NO TRACER), INITIAL IMPACT on FLOOR RICOCHETING off the WALL and IMPACTING BACK to FLOOR



FIG 6. VIDEO OF 40mm TRACE & MARK in TACOM-ARDEC ATF



FIG 7. DAY TIME VIEW OF TARGET

at PICATINNY OUTDOOR RANGE



FIG 8. ROUND MARKING TARGET at DUSK

at PICATINNY OUTDOOR RANGE

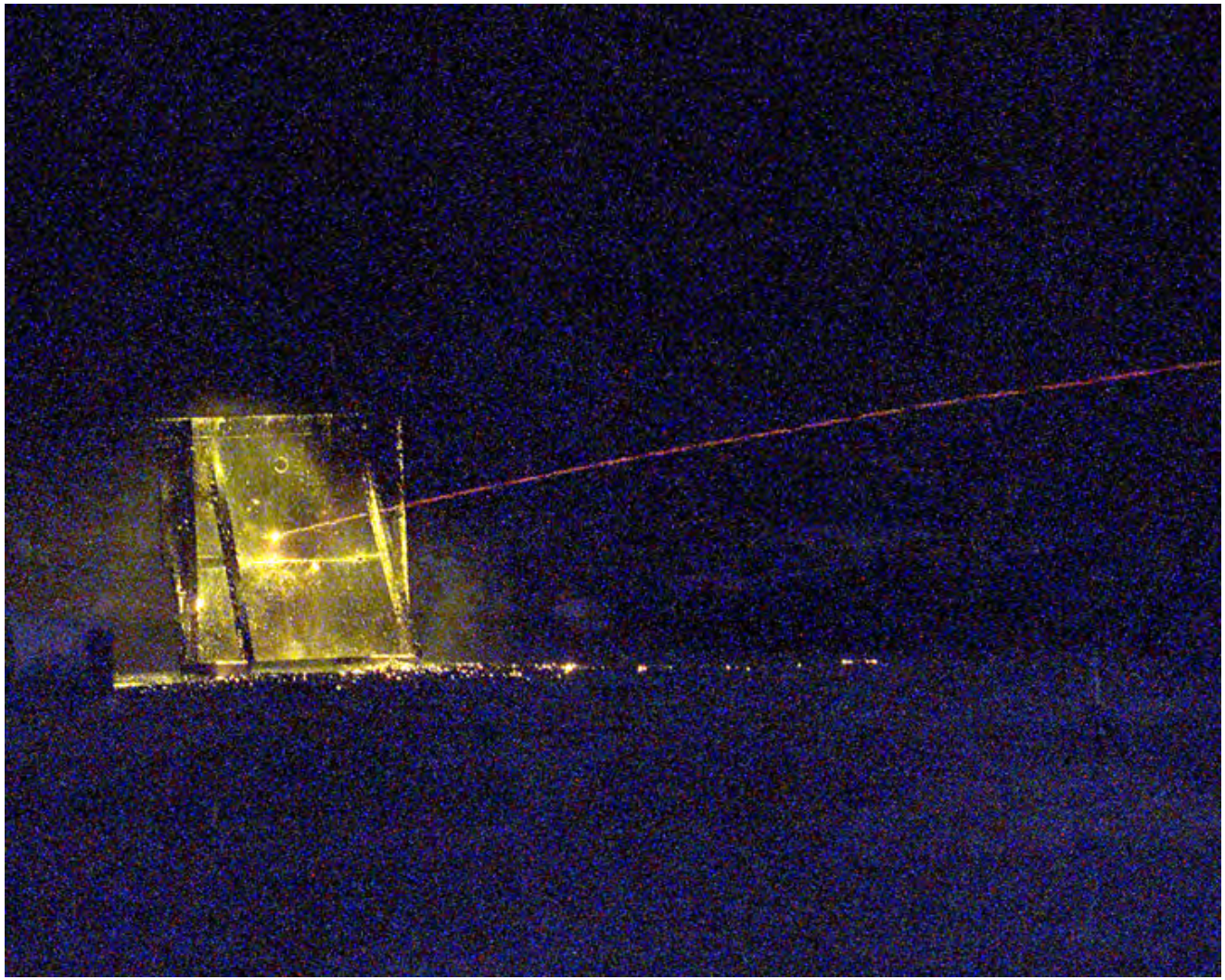


FIG 9. ROUND FIRED at NIGHT

at PICATINNY OUTDOOR RANGE



FIG 10. VIDEO of FLAMELESS TRACE & MARK

at PICATINNY OUTDOOR RANGE

ARDEC Points of Contact

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  Stew Gilman

  email: sgilman@pica.army.mil

  (973) 724-7088

  Leon Manole

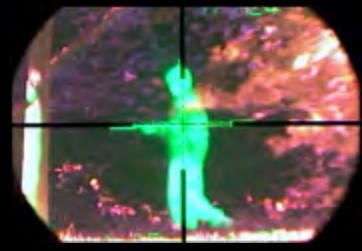
  email: lmanole@pica.army.mil

  (973) 724-6516

SNIPIR: HIGH PERFORMANCE COOLED THERMAL IMAGING WEAPON SIGHT

NDIA Small Arms Symposium FLIR Systems, Inc.







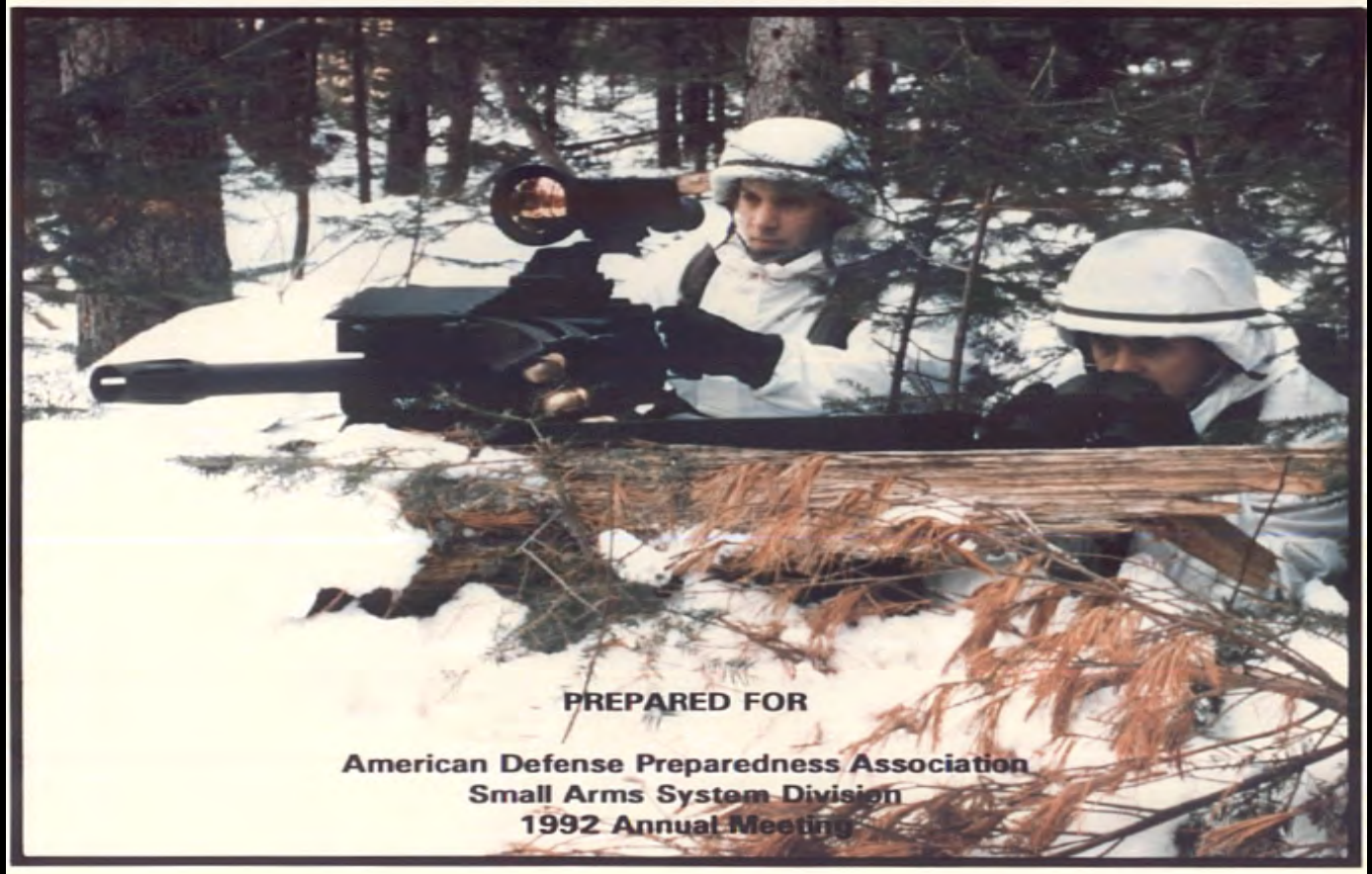
Presented By:
JOHN G. LOOBY
15 May 2002

SNIPIR™

FLIR SYSTEMS

BEEN HERE BEFORE

MAG-600
MULTIPURPOSE THERMAL SIGHT



By: John G. Looby
Manager, Business Development, Advanced Programs
Magnavox Electronic System Company
Electro-Optical Systems Division
46 Industrial Avenue, Mahwah, New Jersey 07430 (201)529-1700

PRESENTATION OUTLINE

- Company Overview
- User Needs
- Program History
- System Description
- Development
- Qual Test Results
- Production Status
- Future Growth

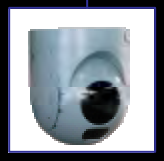
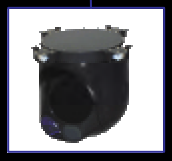
BROAD SPECTRUM

AIRBORNE













GROUND











MARITIME





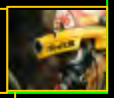

THERMOGRAPHY







FIRE






SNIPIR™

FLIR SYSTEMS

GROUND

FLIR has a solution for virtually every critical ground based application including force protection, surveillance, border patrol, perimeter security and special operations.





SNIPIR™

FLIR SYSTEMS

SNIPIR

NEED

- Long Range Targeting Visual Augmentation System That:
  DOES NOT TOUCH MY SCOPE!
- Clip-On Device

TECHNOLOGY

- High Sensitivity IR Imager Folded Into a
- Visible Light Day Scope
- Resulting In **Image Fusion**
- Low Power Cooler/OTS Battery

CDMQ





PROGRAM HISTORY

- Development Program Start: Oct “98”
- 3 Qual Units Shipped: Jan “00”
- Qual Tests: Mar “00”
- User Tests: thru Sept “00”
- Optic Upgrade: Oct “00”
- Re-Qual Optic: Nov “00”
- Production Award: May “01”
- Production Deliveries: Ongoing

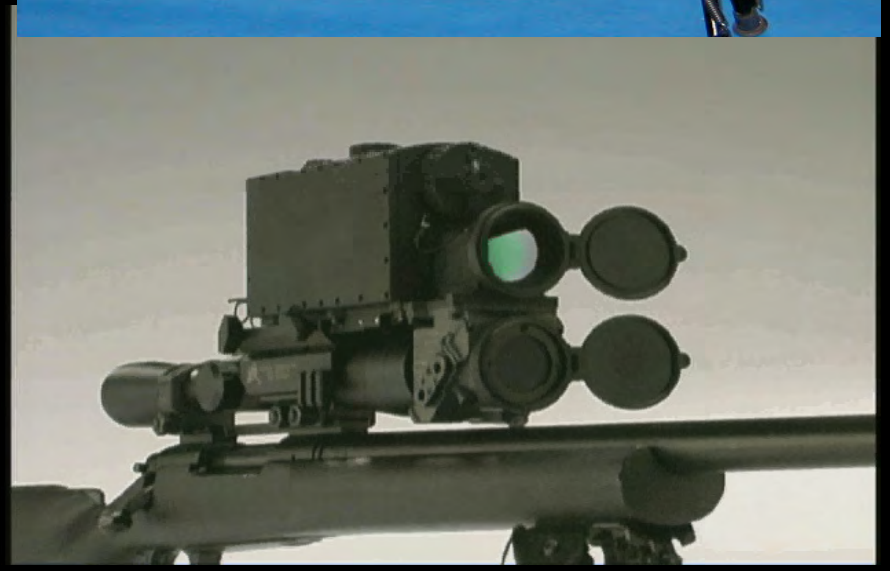
OPTICS EVOLUTION

- Original Requirement Called for Interchangeable Thermal Optics:

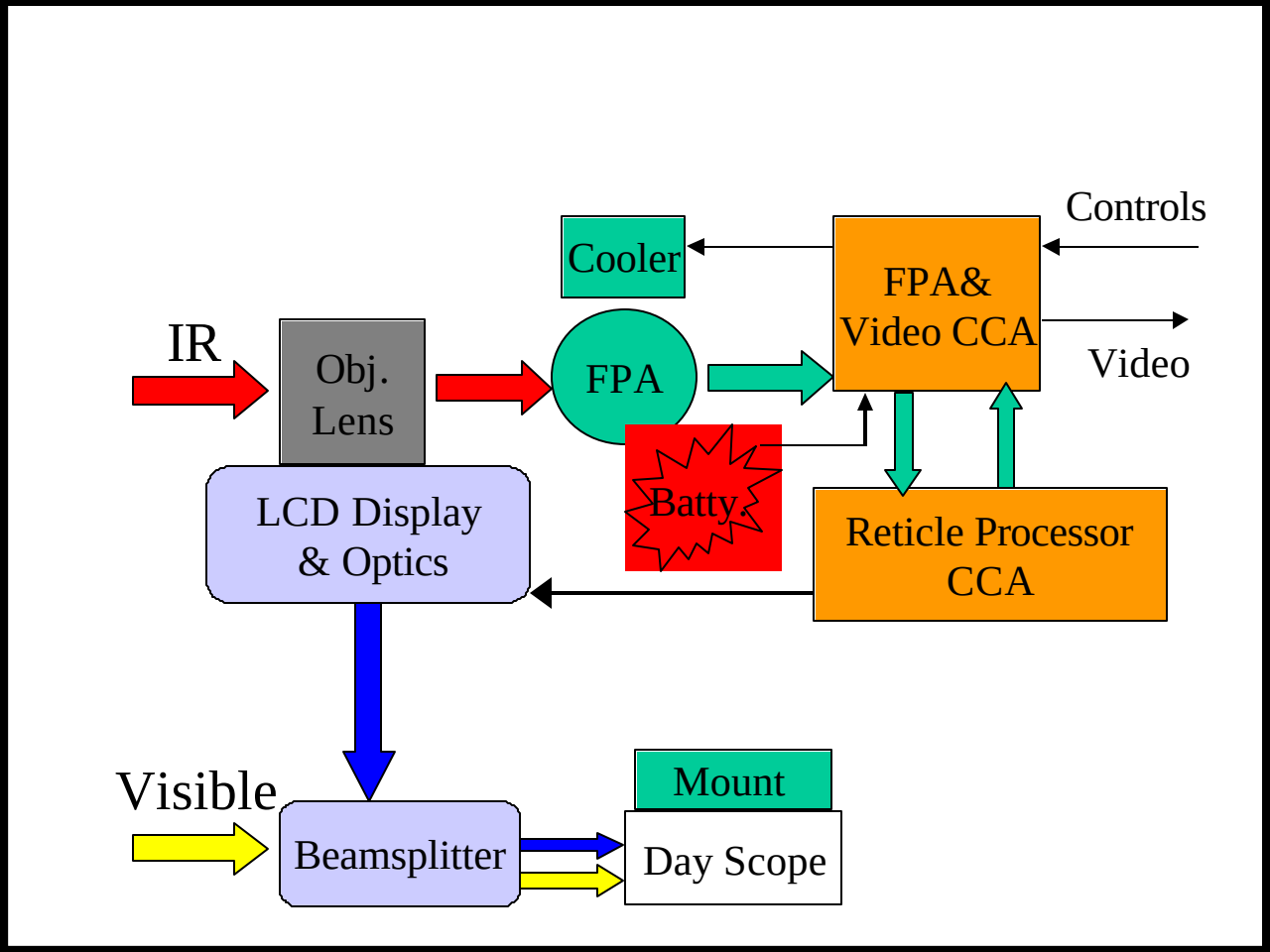
  75 & 150 mm Lenses
- 10X Leupold, Through Beamsplitter Provides Thermal Image Magnification
- Redesign Imbeded LCD Display in IR Telescope
- Redesign: **Reduced**

  1 lb. in System Weight, and 1.25” in System Height
- Prior to Production





SYSTEM DESCRIPTION



Components:

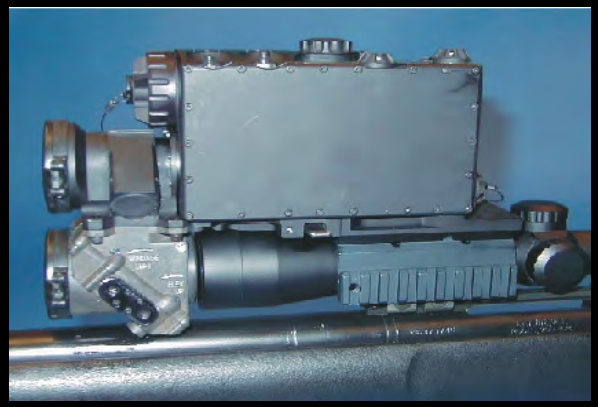
- TIPS Imager
- Objective Lens
- Beam Splitter
- Scope
- Mount

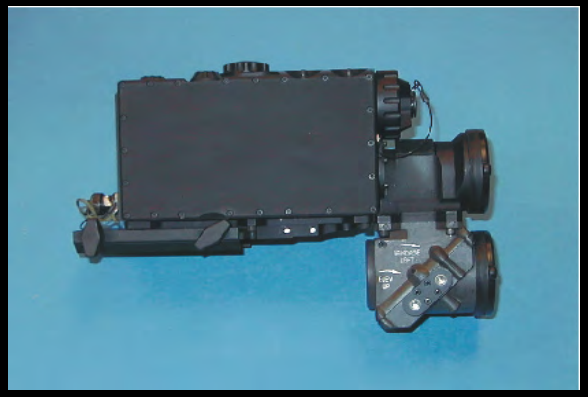
SYSTEM SPECS

- RANGE: Recognize a Man > 1500 meters
- TECHNOLOGY: Cooled InSb Focal Plane
- OPTICS: 150 mm, f/4.0 (0.20 mr)
- DISPLAY: Green LCD, Through Scope / Beamsplitter
- WEIGHT: 4.5 lbs, Including Battery
- POWER: Single 3.6VDC Li ”D”- Cell Battery
- Environmental: Sealed, Diveable to 66 Feet
- IMAGE: Visible or Thermal or **FUSED!**

SNIPIR VIEWS









SYSTEM VIDEO



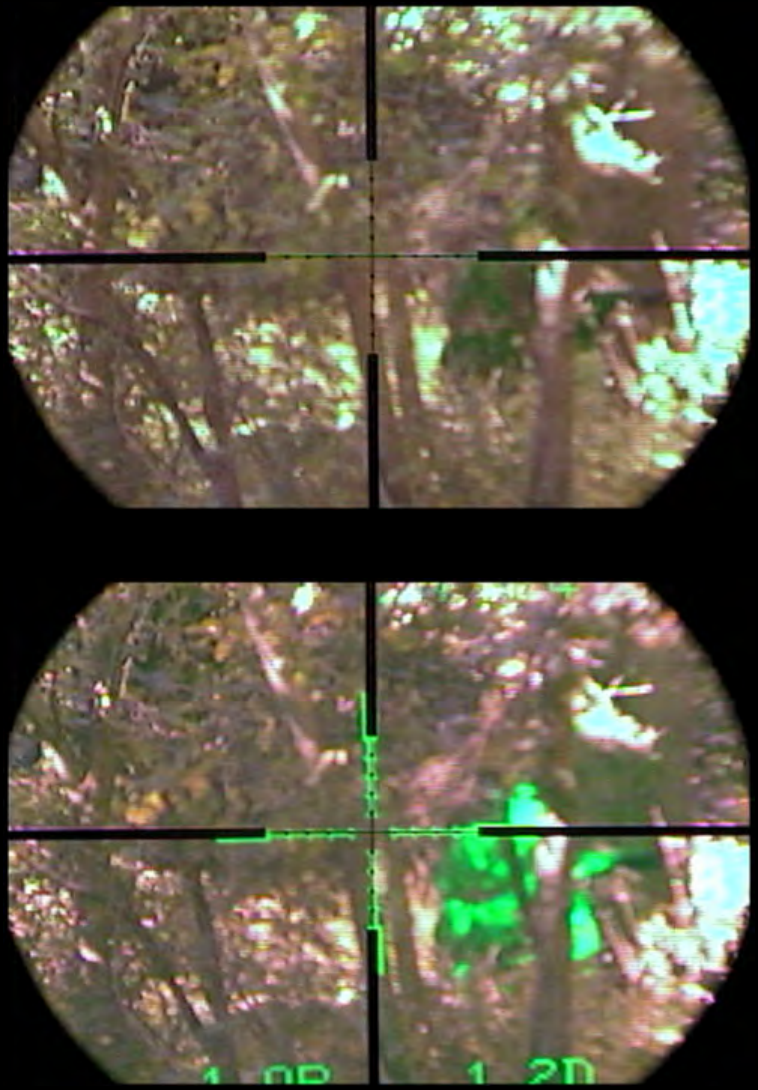
FUSION VIDEO



SNIPIR™

FLIR SYSTEMS

USER VIEWS





BORESIGHT PROCEDURE

- Zero In Day Scope (At a Desired Range)
  - Current Requirement 200 Meters
- Activate/Enable/ Turn on **SNIPIR**
  - Open Lens Cap
- Adjust Beam Splitter Mirror
  - Super Impose Visible and Thermal
- Re-Live Fire
  - Until Consistent Shot Groups

QUAL TESTS RESULTS

- Imager Significantly Out Performed Spec.
- Live Fire Qual: 300 Rounds-.300 Win Mag
- Shoot Groups: <6 in @ 600 yds (<1.0 MOA)

- Three Qual Systems have Several Thousand Rounds Fired to date:

  (since Mar “00”)

  Without Failure!

PRODUCTION TEST



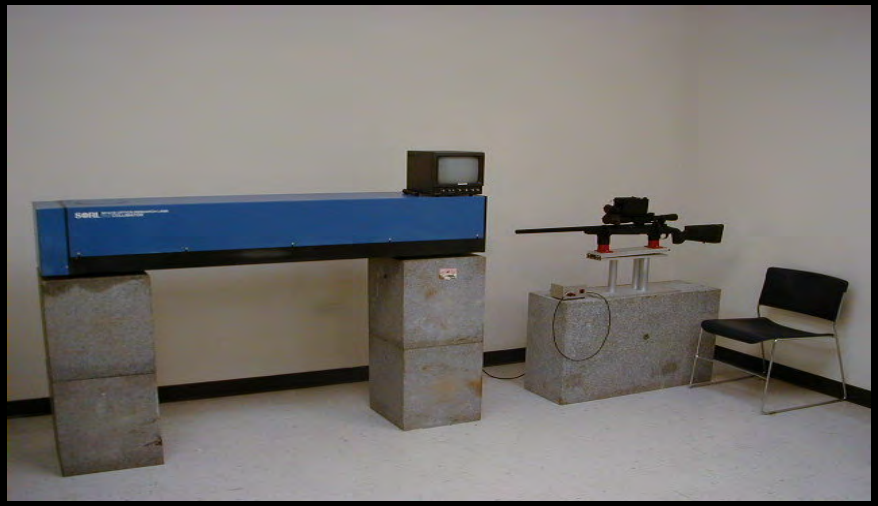
Monthly Production



Immersion Test



Bullet Trap



Collimator

ADDITIONAL APPLICATIONS

- SNIPIR Mods For Variable Scope
- SNIPIR Mods For Higher Power Scopes

- MIRV
  - Crew Served Weapons
  - STINGER Night Sight
  - MK 38 Deck Gun



- See Spot III
  - Forward Observer
  - Combat Air Controller

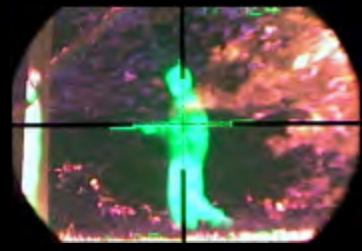


SUMMARY

- **SNIPIR Is Fully Qualified**
- **SNIPIR Is In Production**
- **SNIPIR Has Proven Consistent Performance**

- **SNIPIR Is The Visual Augmentation Clip-On System of Choice**







JUST A SHOT IN THE DARK



SNIPIR