

2008 NDIA
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Gun & Missile Systems Conference & Exhibition
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LW30mm (30 x 113mm) Spotter Charge Prototype

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Bradley with M242, 25mm



LW25mm Bushmaster



Medium Caliber Ammunition



M230 Chain Gun



- **Background and Need**
- **Technical Approach**
- **ATK Testing**
- **Testing at Ft. Rucker**
- **Acknowledgements/Contacts**
- **Questions & Answers**

LW30 Ammunition – 30mm X 113mm



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#4690



#11261

M789 HEDP

– High Explosive Dual Purpose

Length (max): 113 mm
Weight: 343 g
Projectile Mass: 234 g
Muzzle Velocity: 805 m/s
Max Range: ~ 3000 m
Dispersion: 1.35 mils

M788 TP

– Training Projectile matched to M789



M230 Weapon System



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- **30mm M230 Chain Gun Automatic Cannon**
- **Caliber:** 30mm X 113mm - LW30 Linkless
- **Max Range:** ~ 4000 meters
- **Rate of Fire:** 625 \pm 25 Shots per Minute
- **Platforms:**
 - AH-64 / AH64A Apache Attack Helicopters
 - MH-60 Variants - SOAR
- **Targets:**
 - Light Armored Vehicles
 - Deployed Infantry

Market Survey / Sources Sought Solicitation – April '07

Solicitation Number W15Q1N-07-X-0665, Issued 4/13/07

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DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY AVIATION WARFIGHTING CENTER AND FORT RUCKER
453 NOVOSEL STREET
FORT RUCKER ALABAMA 36362-5105

Memorandum May '07 states additional desired capabilities definition

• Visibility requirements:

• "...Visible 0 to 3000m

• Day - Unaided eye, FLIR, D

• Night - Unaided eye, FLIR, NV goggles

• Target media

• "...packed soil, cement, 3/4 plywood, hard metal targets,....."

• Ammunition should be non-dud producing

• Expected to be a NDI (Non-Developmental Item) solution

• Demonstration testing to be conducted at Ft. Rucker late '07 timeframe

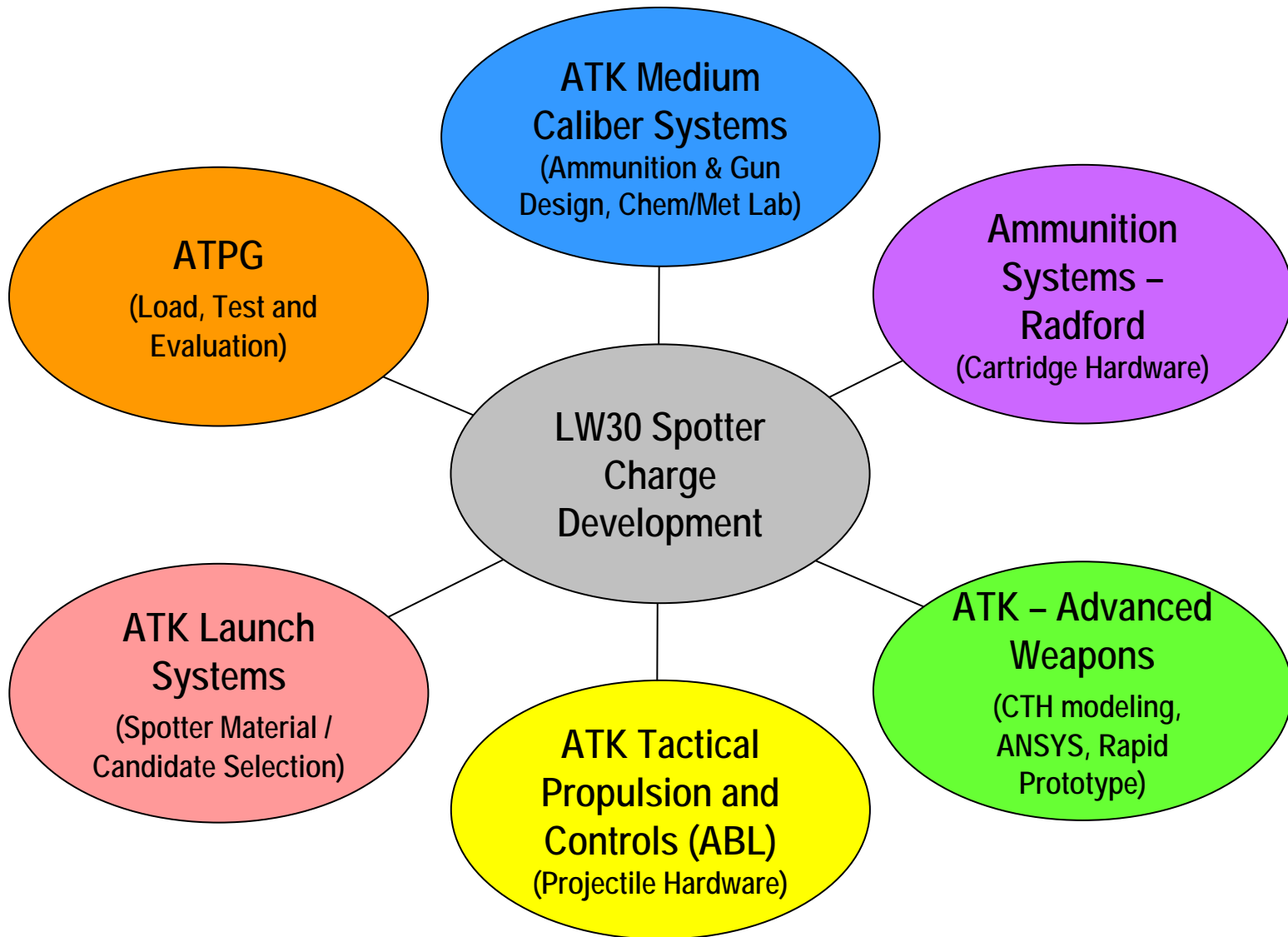
Customer includes:

- Ft. Rucker – Army Aviation Training Center/ Training and Doctrine Command (TRADOC) TCM (Tradoc Capability Manager)
- US Army Office of the Project Manager Maneuver Ammunition Systems (OPM-MAS)
- Armament Research, Development and Engineering Center (ARDEC)

LW30 Spotter Charge – ATK Team



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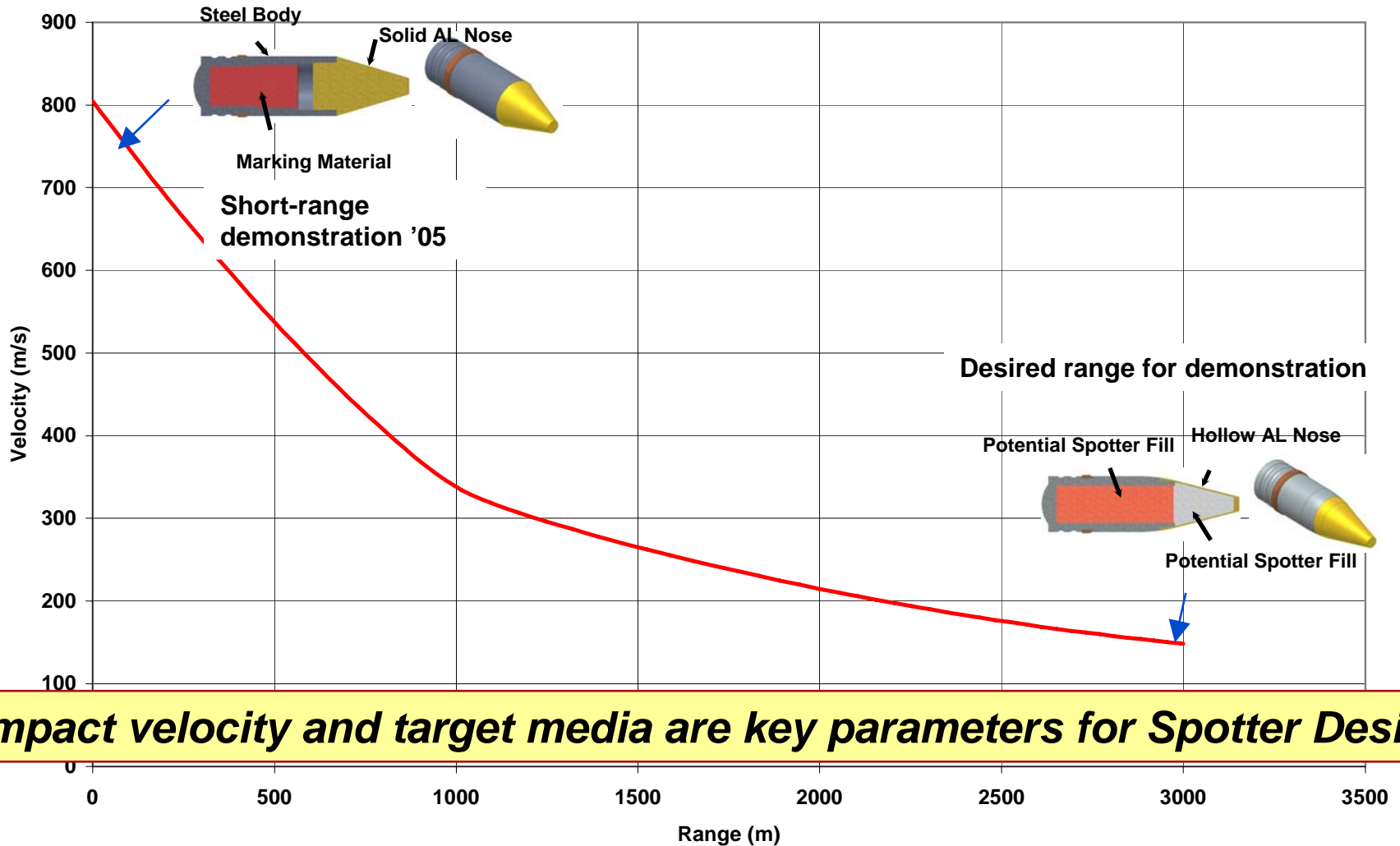


Spotter Charge – Design Challenges



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M788 TP Projectile Velocity vs. Range



Impact velocity and target media are key parameters for Spotter Design

Material Selection – Approach



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- **Technical:**

- Approach driven by the desired capability requirements
- Key challenges: Spotter material sensitivity against soft ground target and reaction against plywood

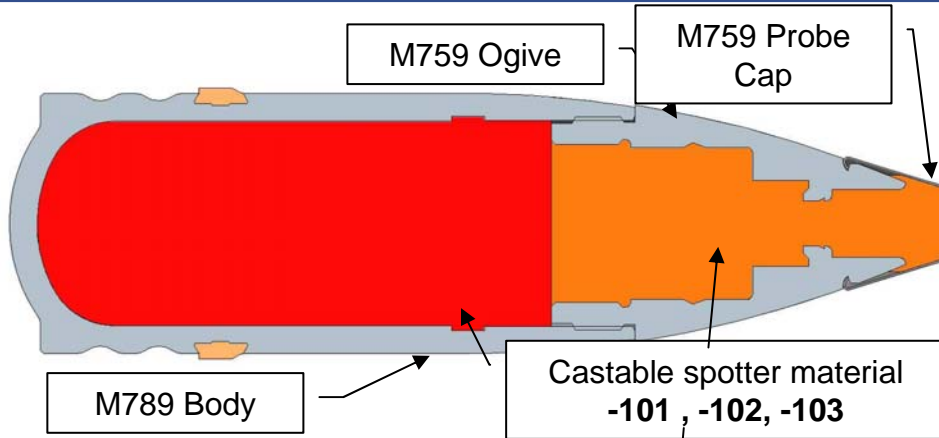
- **Schedule**

- “Off the shelf” material currently in use at ATK-LS
- Castable material due to time constraints of load tooling and integration with projectile geometry changes

- **Selection**

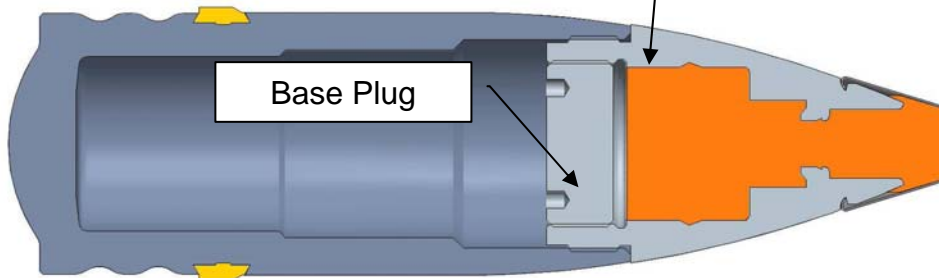
- Identified 3 initial material candidates to be evaluated in ballistic capability testing
- Down selected to most viable materials for highest probability of success on target media

ID	Description
X-9	<ul style="list-style-type: none">• Magnesium powder• Strontium Nitrate (Red marker)• ATK-LS proprietary binder
X-5	<ul style="list-style-type: none">• ATK-LS proprietary Flare formulation• Potassium perchlorate
X-8	<ul style="list-style-type: none">• Magnesium powder• Sodium Nitrate (White marker)• ATK-LS proprietary binder



To address the aggressive schedule for demonstration, existing M788 or M789 projectile hardware will be used or altered to accommodate spotter material cast loading.

Spotter Material in Projectile Body & Nose Assembly



Spotter Material in & Nose only



As-mixed



Dispensing gun into Projectiles

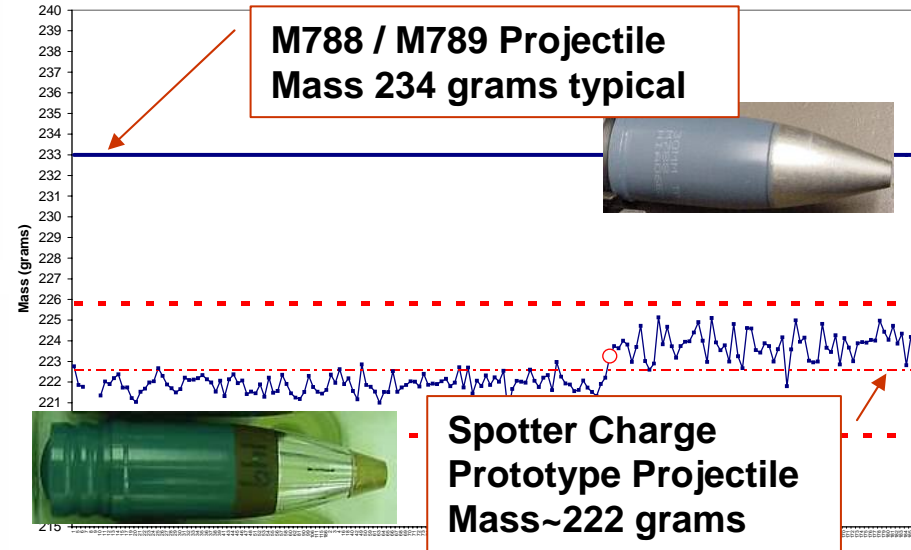
PRODAS Modeling for Ballistic Match to M788/M789



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Projectile Assy (grams) -Measured - All Samples Config 1 and Config 2
LW30 Spotter Charge Demonstration Projectile Build

**M788 / M789 Projectile
Mass 234 grams typical**



**Spotter Charge
Prototype Projectile
Mass~222 grams**



Baseline M789 Model in PRODAS Library

Baseline M788 Model in PRODAS Library

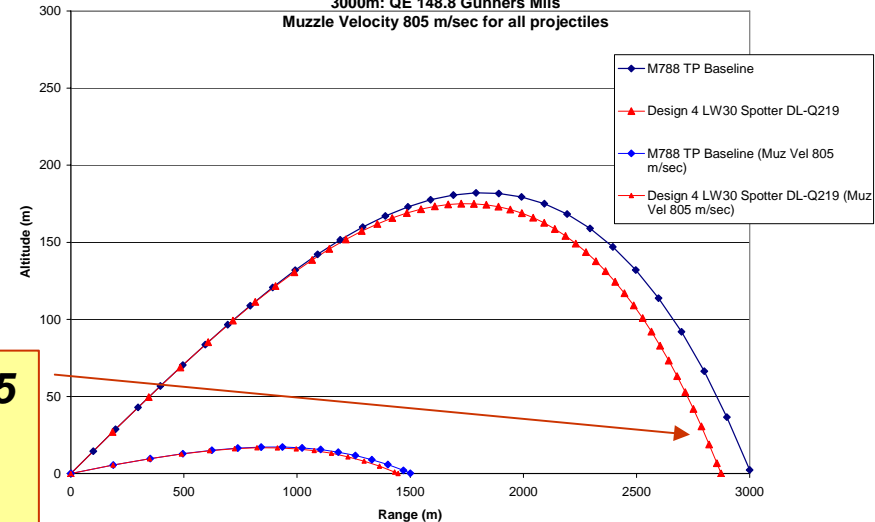
Initial LW30 Spotter Charge Model

PRODAS Trajectory Comparison for 1500m & 3000m

1500m: QE 31.4 Gunners Mills

3000m: QE 148.8 Gunners Mills

Muzzle Velocity 805 m/sec for all projectiles



Trajectory at 3000m short for same QE and 805 m/s muzzle velocity; increase MV to attain match for spotter to 3000m

Ballistic Match – PRODAS Trajectory Plots for 1500m

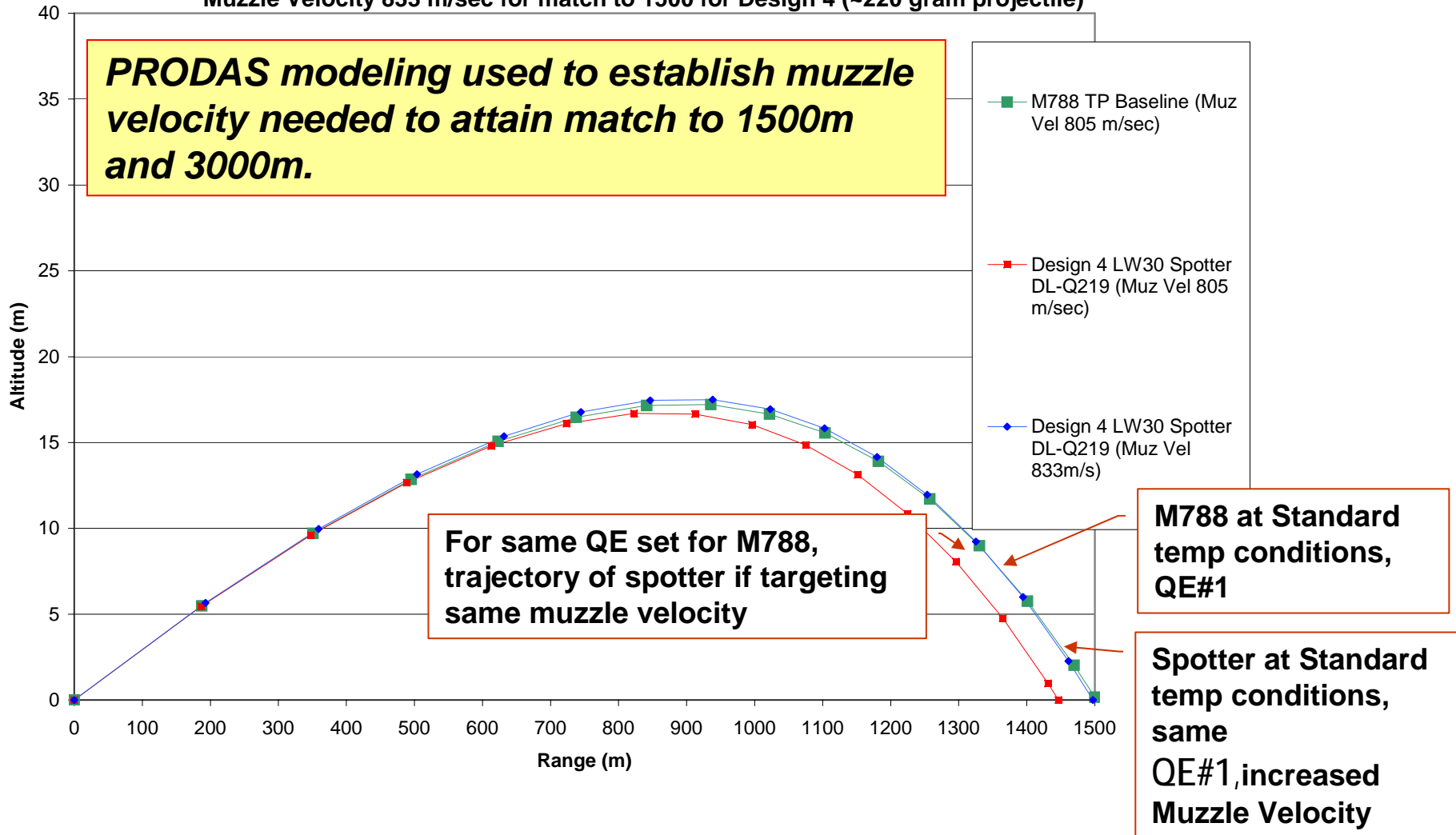


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PRODAS Trajectory Comparison for 1500m - QE 31.4 Gunners Mils

Muzzle Velocity 805 m/sec

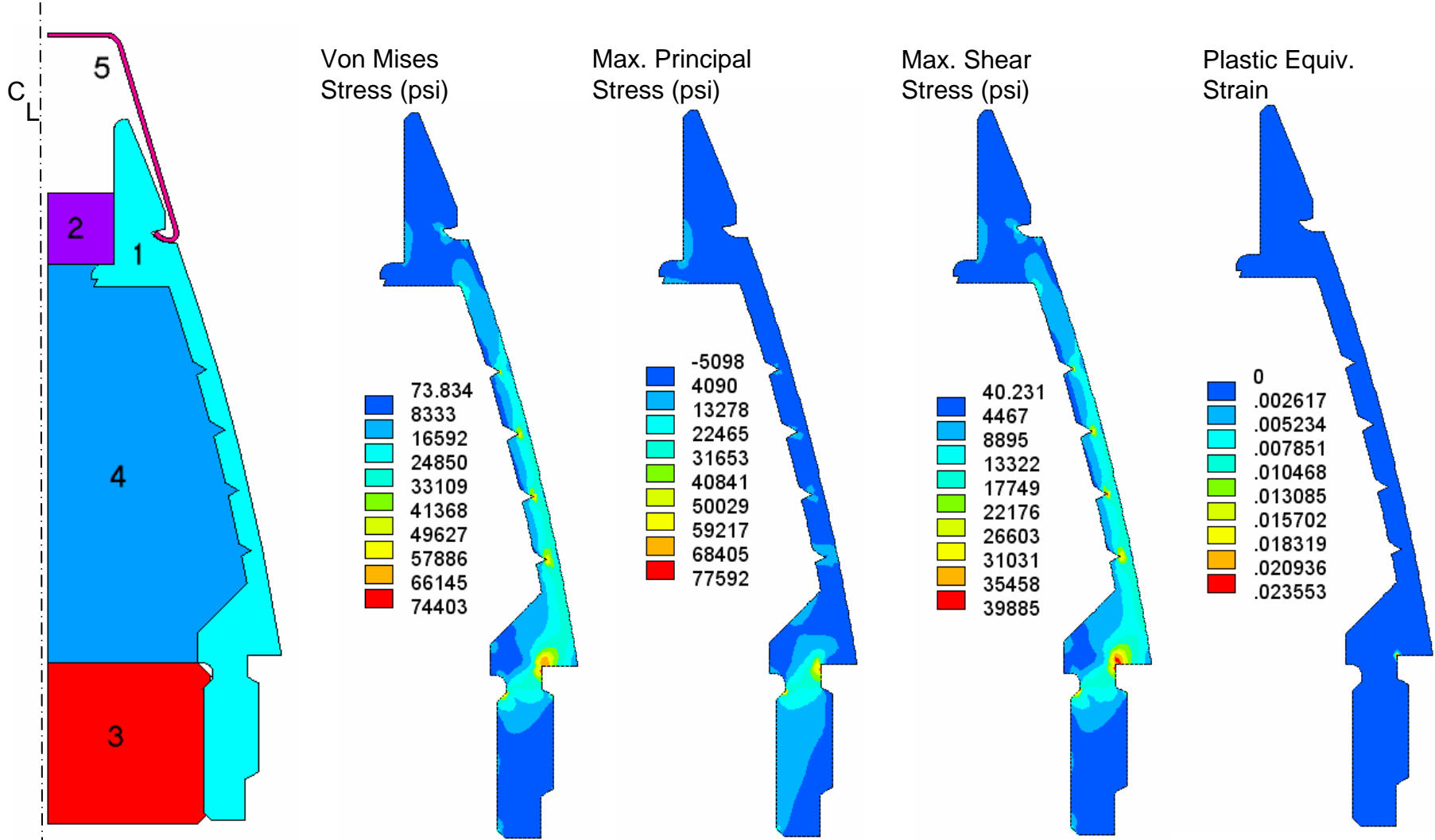
Muzzle Velocity 833 m/sec for match to 1500 for Design 4 (~220 gram projectile)



ANSYS Stress Analysis for Ogive



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Initial Geometry

Ogive wall thickness will survive gun launch loads

Ground Impact – Trajectory Plots

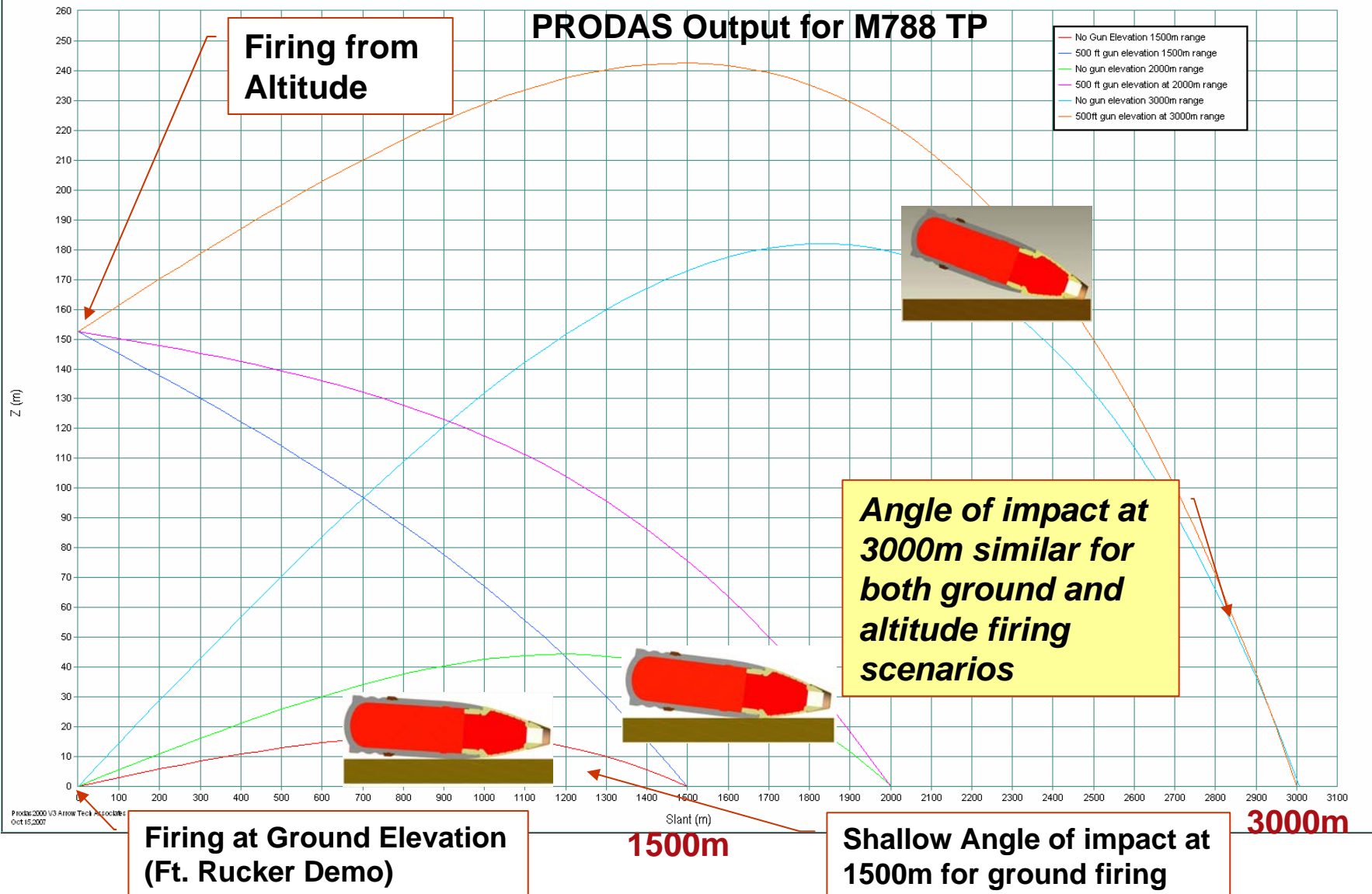
1500m / 2000m / 3000m – Gun at 0 vs. Altitude



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PRODAS Cross Plot of Trajectories at 1500m, 2000m, and 3000m ranges at 0 and 500ft gun elevation

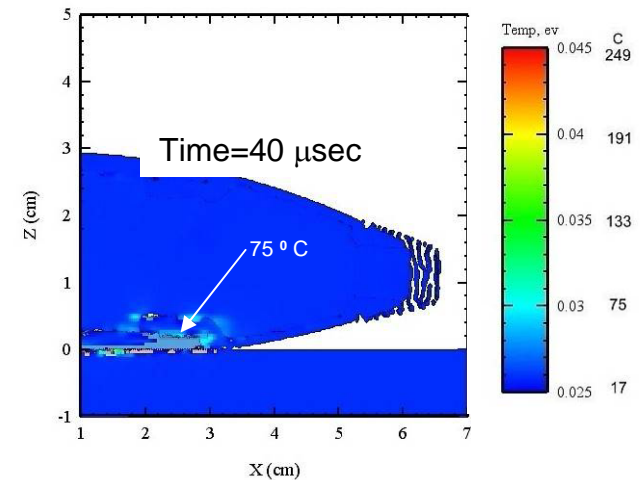
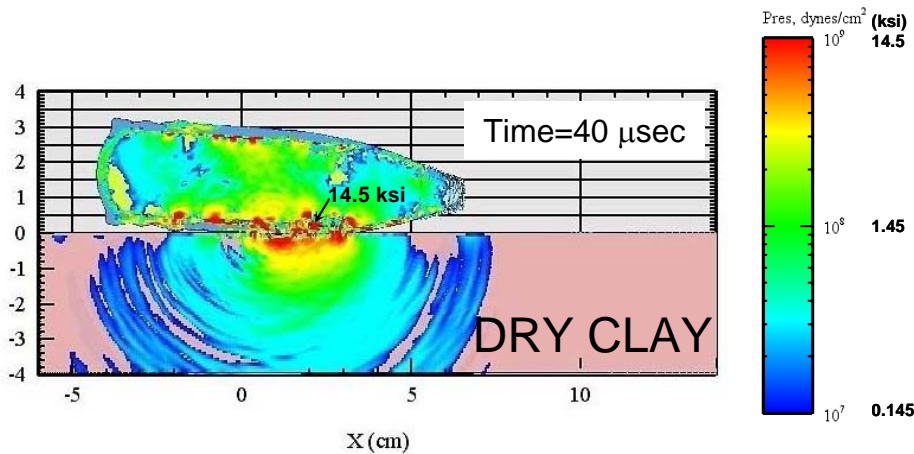
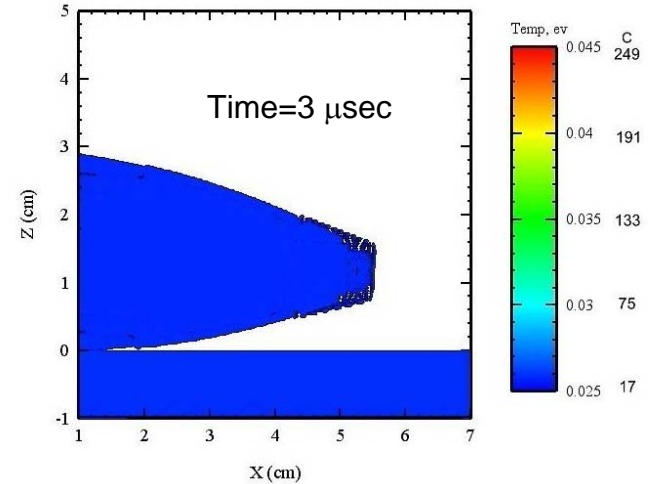
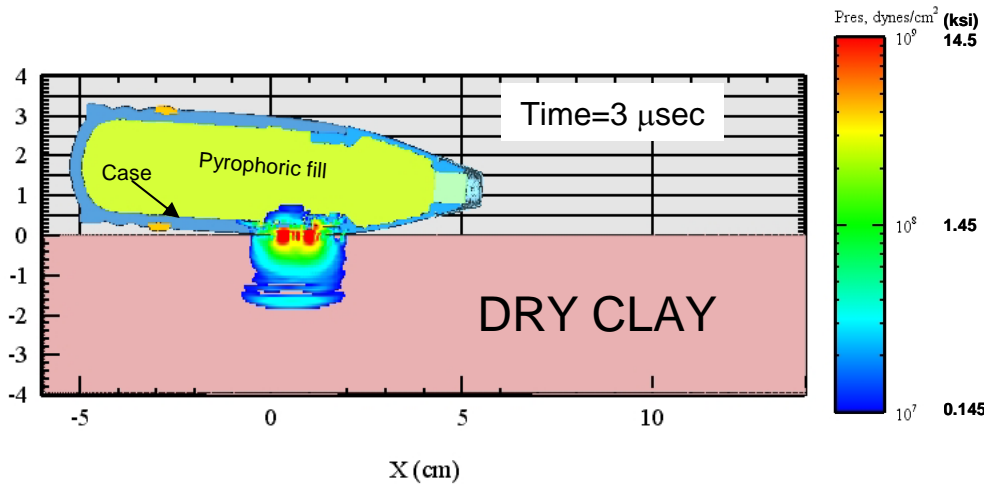
PRODAS Output for M788 TP



CTH Modeling of Ground Impact – 1500m

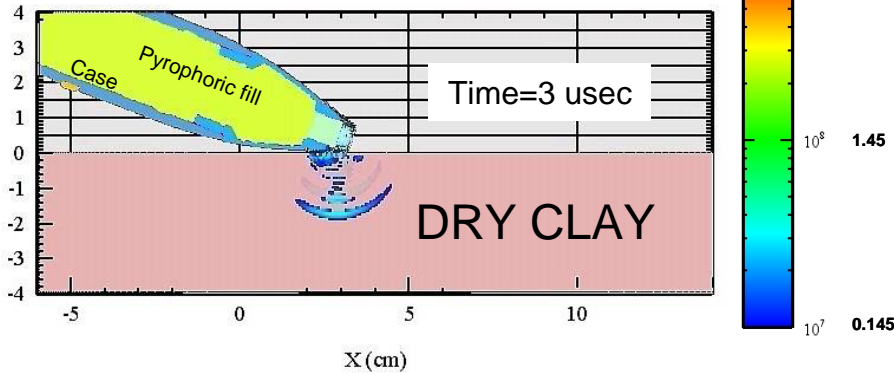


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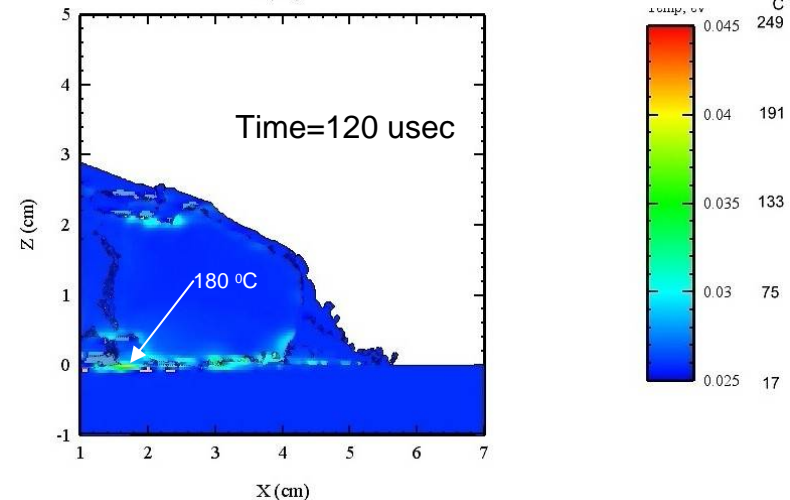
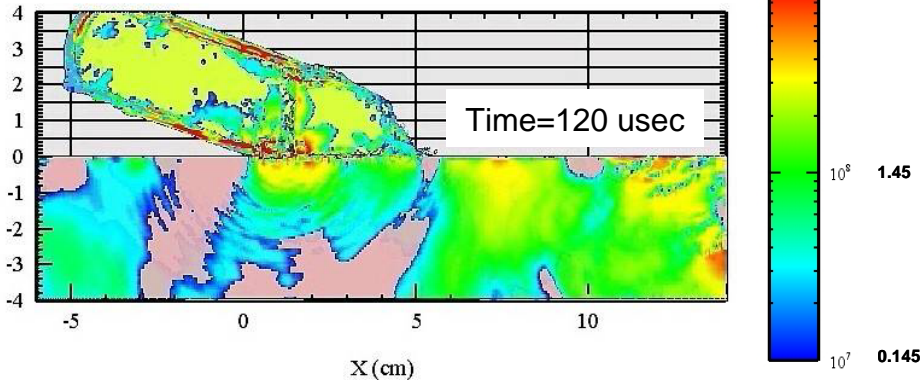
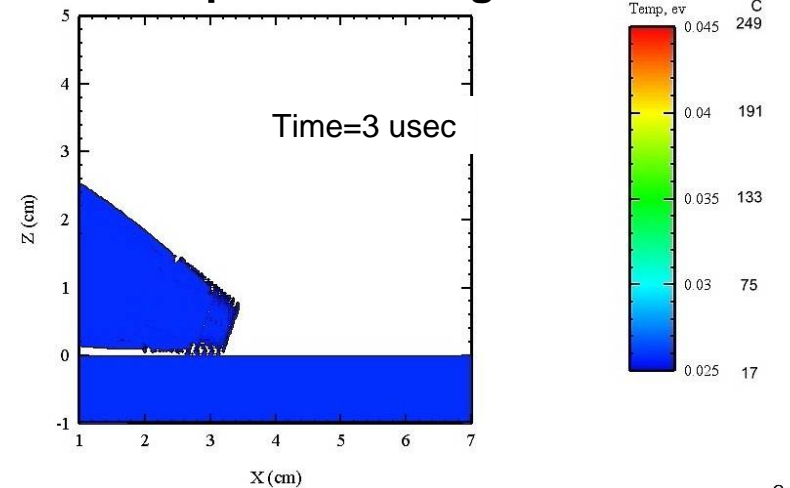


1500m test at Ft. Rucker fired from ground-mount will produce shallow angle of impact that will make it difficult to initiate spotter fill.

Pressure Fringes



Temperature Fringes

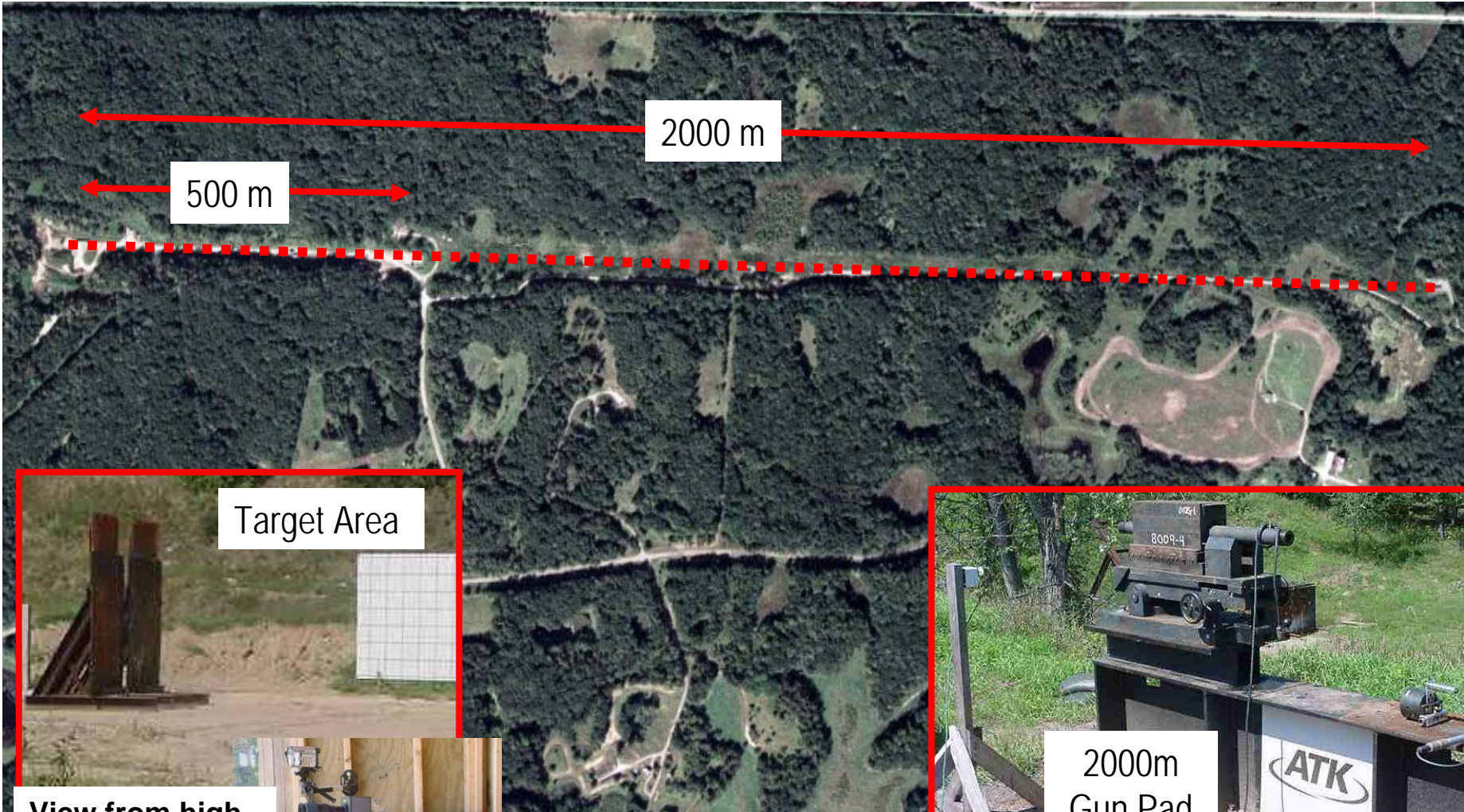


Increased angle of impact at 3000m may provide increased shear or thermal stress upon impact; however the impact velocity is reduced

2000m Test Range at ATPG



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Target Area



View from high-speed camera to target



2000m Gun Pad

Aerial View

Source: Google Earth

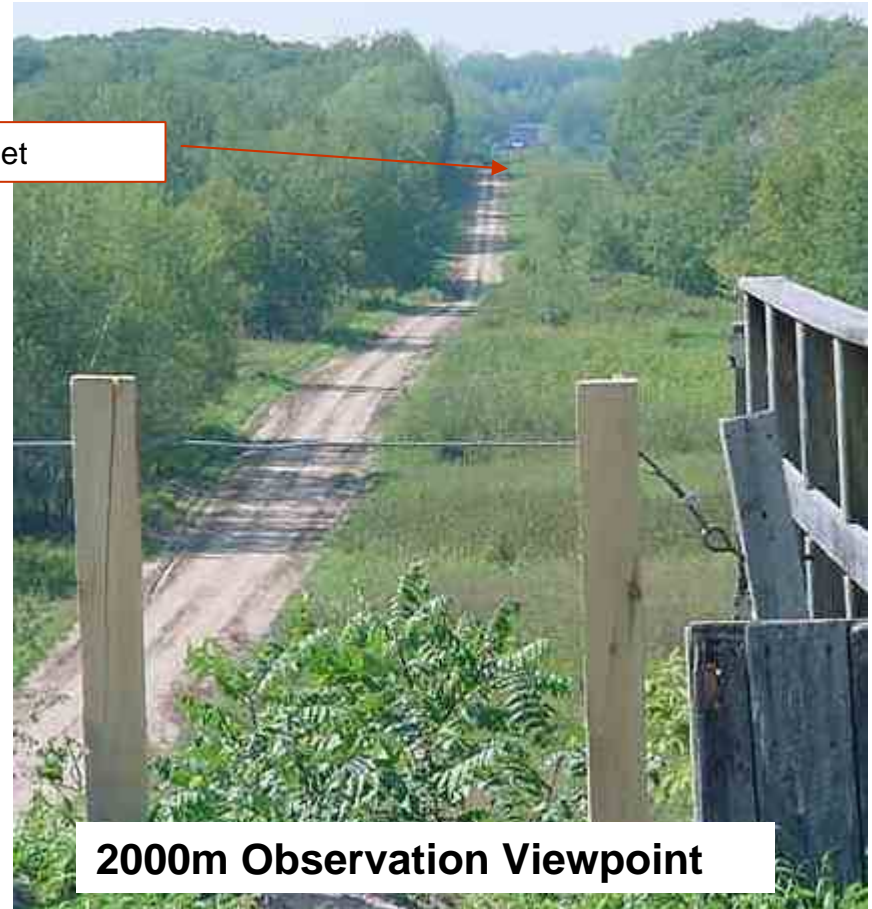
ATPG Test Setup Photos – Gun to Target



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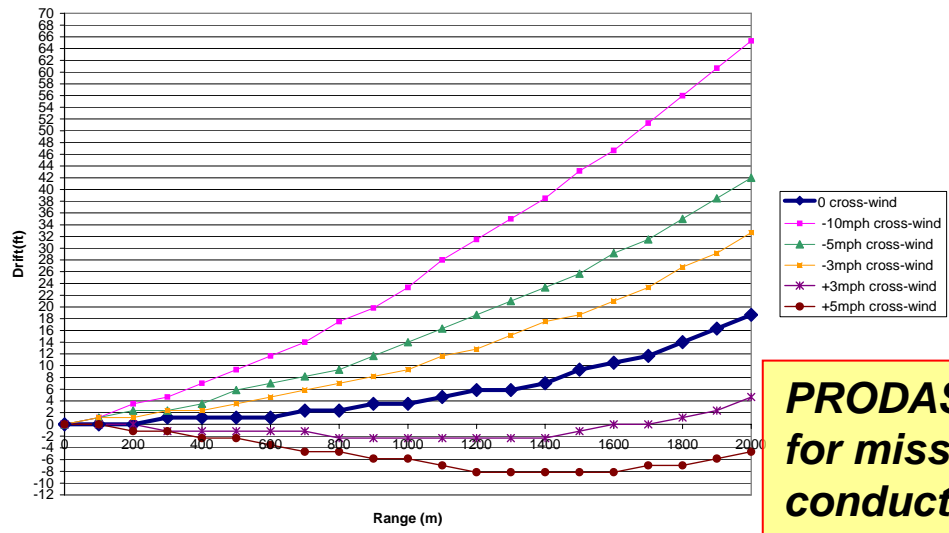


500m Gun Firing Position Viewpoint



2000m Observation Viewpoint

LW30mm Spotter Charge IR&D
M788 TP Drift vs. Range - PRODAS Eval for Cross-Wind
Firing at 2000m vs 16' wide RHA plate

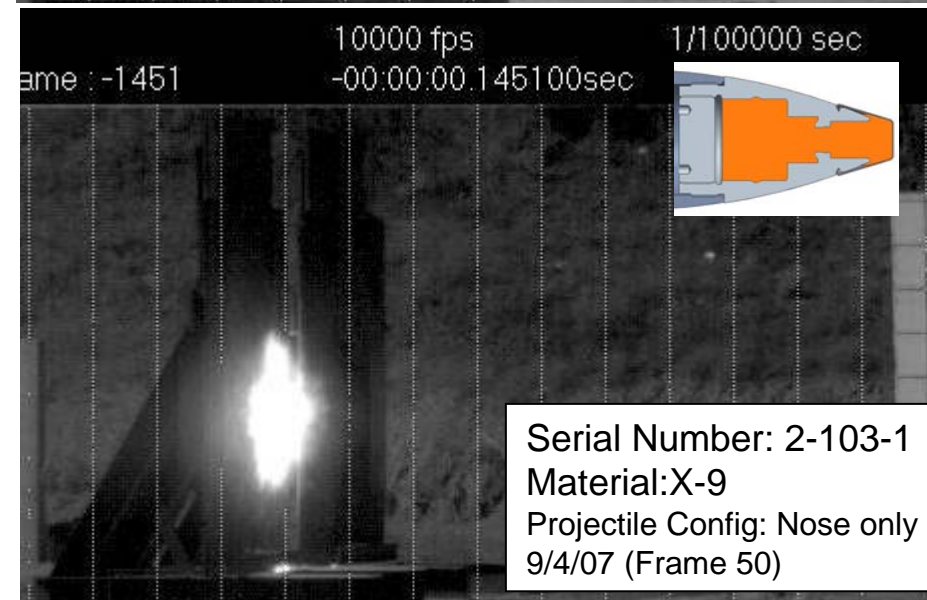
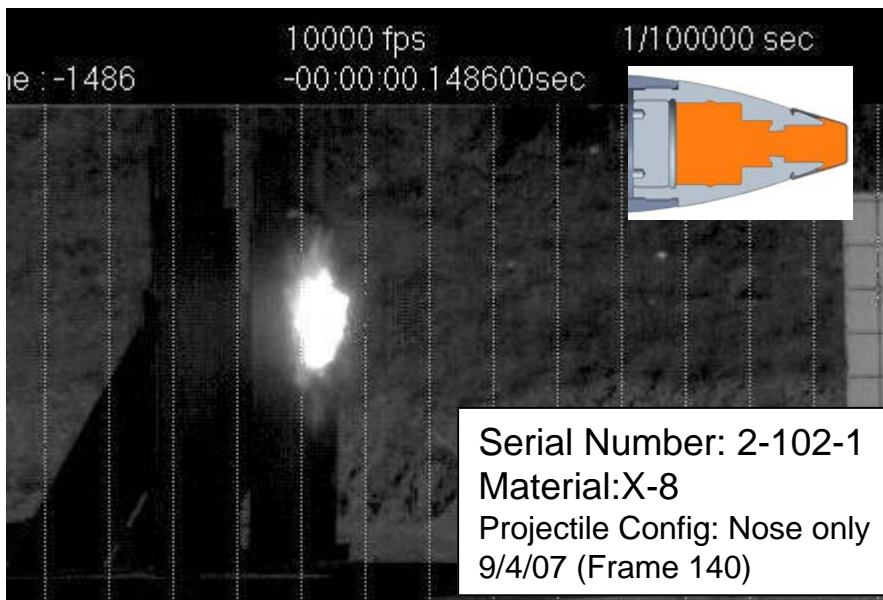
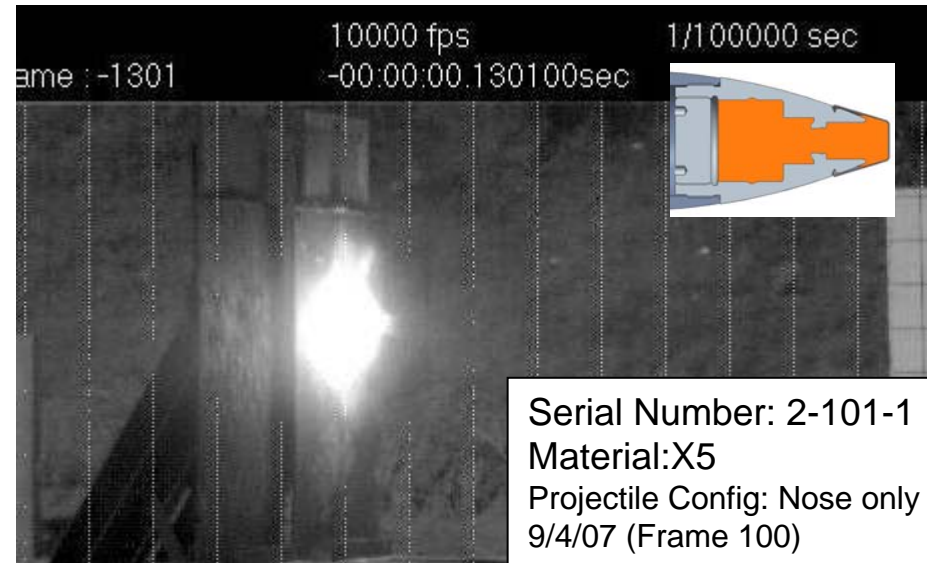
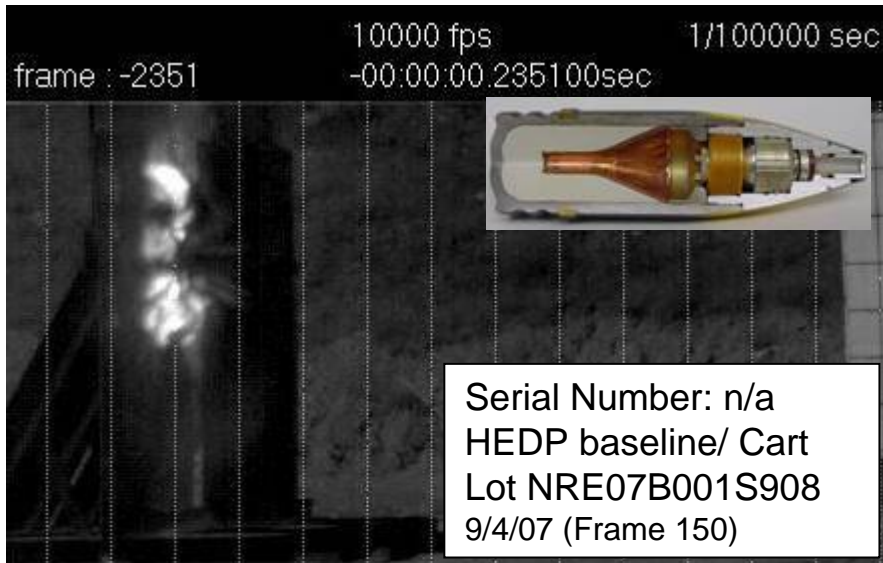


PRODAS Modeling for cross-winds showed risk for missing test target at 2000m; therefore conducted initial capability testing at 500m

ATPG High Speed Video – 500m testing against steel target



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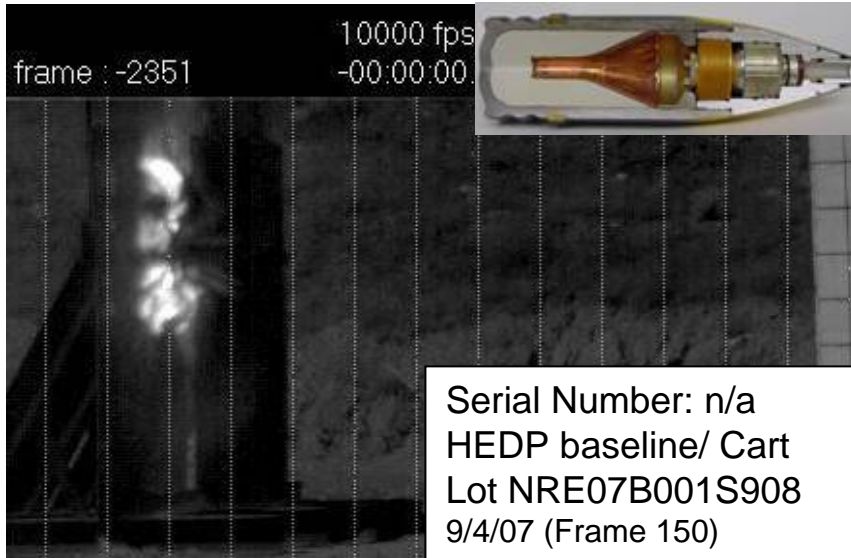
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ATPG High Speed Video - 500m testing against steel target



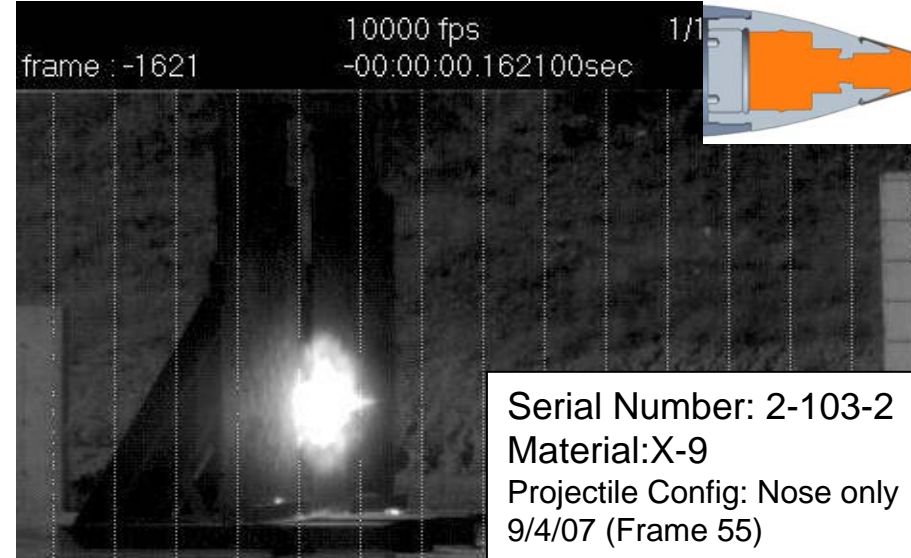
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10000 fps
frame : -2351
-00:00:00.



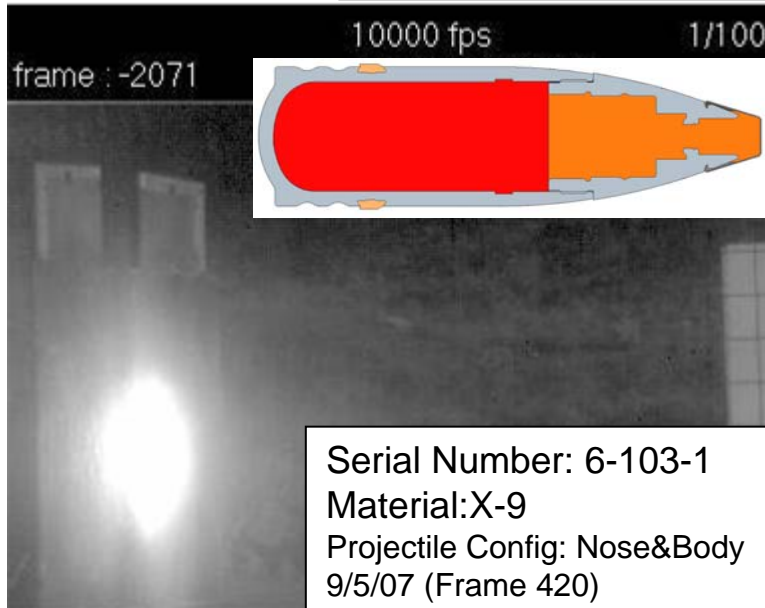
Serial Number: n/a
HEDP baseline/ Cart
Lot NRE07B001S908
9/4/07 (Frame 150)

10000 fps
frame : -1621
-00:00:00.162100sec



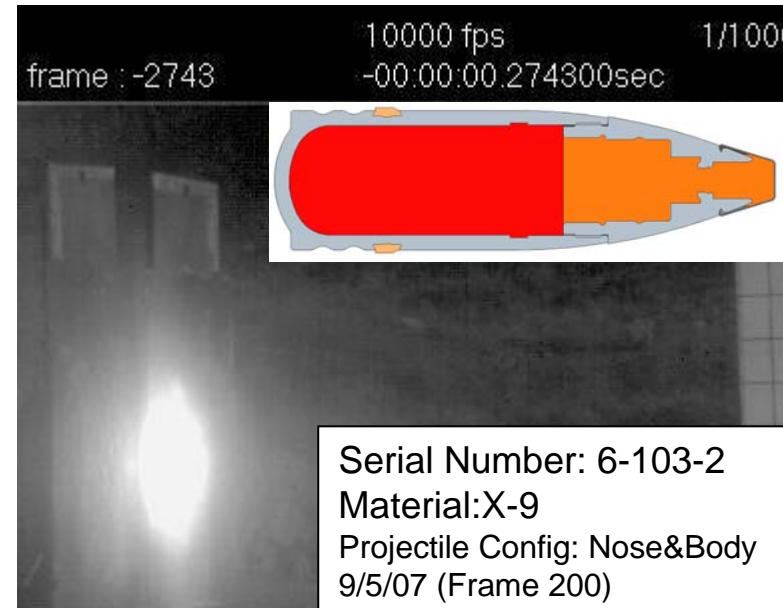
Serial Number: 2-103-2
Material: X-9
Projectile Config: Nose only
9/4/07 (Frame 55)

10000 fps
frame : -2071
1/1000



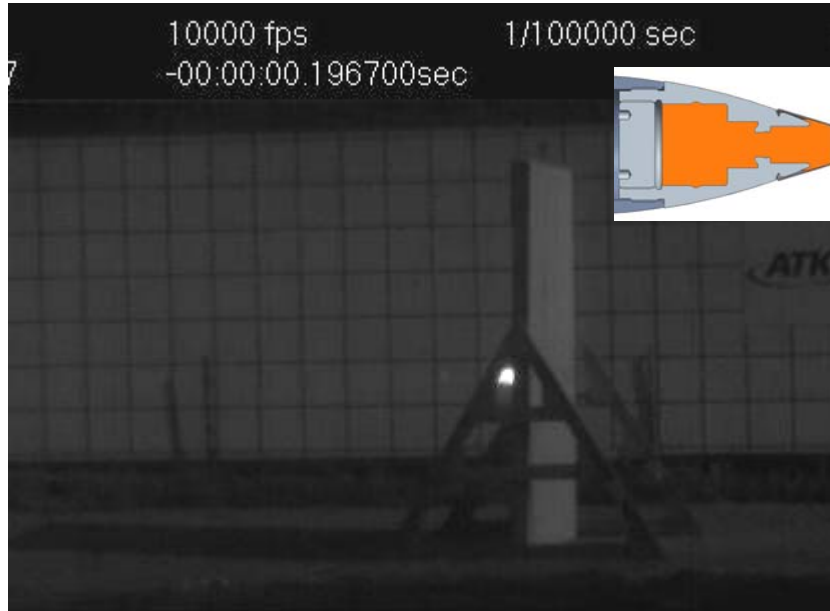
Serial Number: 6-103-1
Material: X-9
Projectile Config: Nose&Body
9/5/07 (Frame 420)

10000 fps
frame : -2743
-00:00:00.274300sec



Serial Number: 6-103-2
Material: X-9
Projectile Config: Nose&Body
9/5/07 (Frame 200)

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- These 2 tests were conducted at 500m with full propellant load and show reaction on plywood in high-speed video, but not visible to unaided eye at gun (500m).
- When fired at 500m with 40% propellant load (simulating 1500m impact) there was no reaction seen on high speed video.

Demonstration Test Plan – Example of 27-Round test block

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Total of 170 cartridges shipped for Demo

							ATK Projectile Config	
	Day or Night	Firing Distance	Viewing Distance	Apache Gunner View	Apache Pilot View	Target	Config 1	Config 2
Day 1	Day	1500m	1500m	Unaided	Unaided	Steel	X	
Day 1	Day	1500m	1500m	Unaided	Unaided	Steel	X	
Day 1	Day	1500m	1500m	Unaided	Unaided	Steel	X	
Day 1	Day	1500m	1500m	Day	Day	Steel	X	
Day 1	Day	1500m	1500m	Day	Day	Steel	X	
Day 1	Day	1500m	1500m	Day TV	PNVS FLIR	Steel	X	
Day 1			500m	TADS FLIR	Unaided	Steel	X	
Day 1			500m	TADS FLIR	Unaided	Steel	X	
Day 1			500m	TADS FLIR	Unaided	Steel	X	
Day 1			500m	Unaided	Unaided	Plywood		X
Day 1	Day	1500m	1500m	Unaided	Unaided	Plywood		X
Day 1	Day	1500m	1500m	Unaided	Unaided	Plywood		X
Day 1	Day	1500m	1500m	Unaided	Unaided	Plywood		X
Day 1	Day	1500m	1500m	Unaided	Unaided	Plywood		X
Day 1	Day	1500m	1500m	Unaided	Unaided	Plywood		X
Day 1	Day	1500m	1500m	TADS FLIR	Unaided	Plywood		X
Day 1	Day	1500m	1500m	TADS FLIR	Unaided	Plywood		X
Day 1	Day	1500m	1500m	Unaided	Unaided	Earth	X	
Day 1	Day	1500m	1500m	Unaided	Unaided	Earth	X	
Day 1	Day	1500m	1500m	Day TV	PNVS FLIR	Earth	X	
Day 1	Day	1500m	1500m	Day TV	PNVS FLIR	Earth	X	
Day 1	Day	1500m	1500m	Day TV	PNVS FLIR	Earth	X	
Day 1	Day	1500m	1500m	DS FLIR	Unaided	Earth	X	
Day 1	Day	1500m	1500m	DS FLIR	Unaided	Earth	X	
Day 1	Day	1500m	1500m	DS FLIR	Unaided	Earth	X	

3 Target Types

3 viewing scenarios

1500 & 3000m firing range

1500 & 3000m viewing range

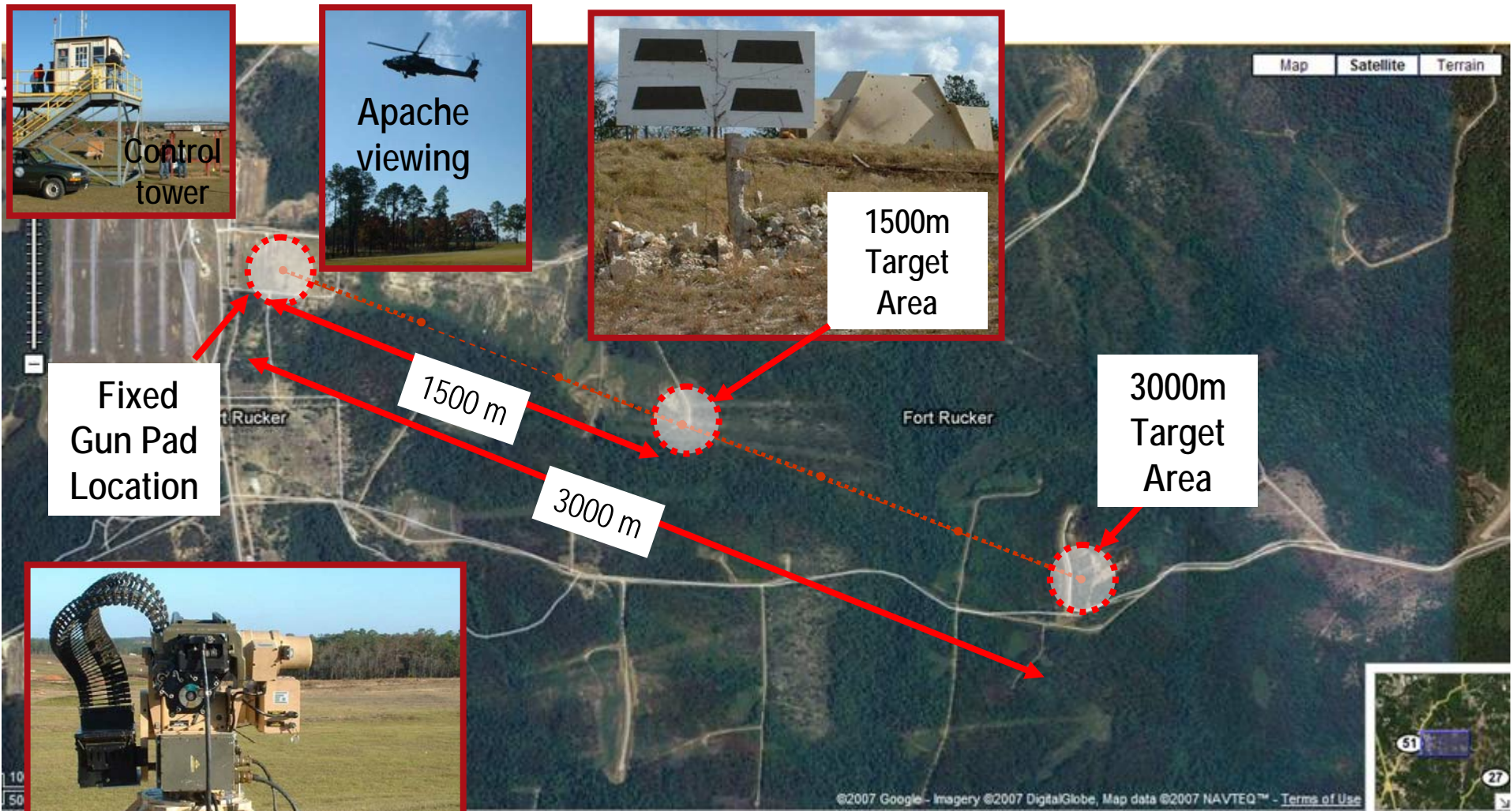
Day & Night firing



LW30 Spotter Charge - Ft. Rucker Demonstration Test Setup



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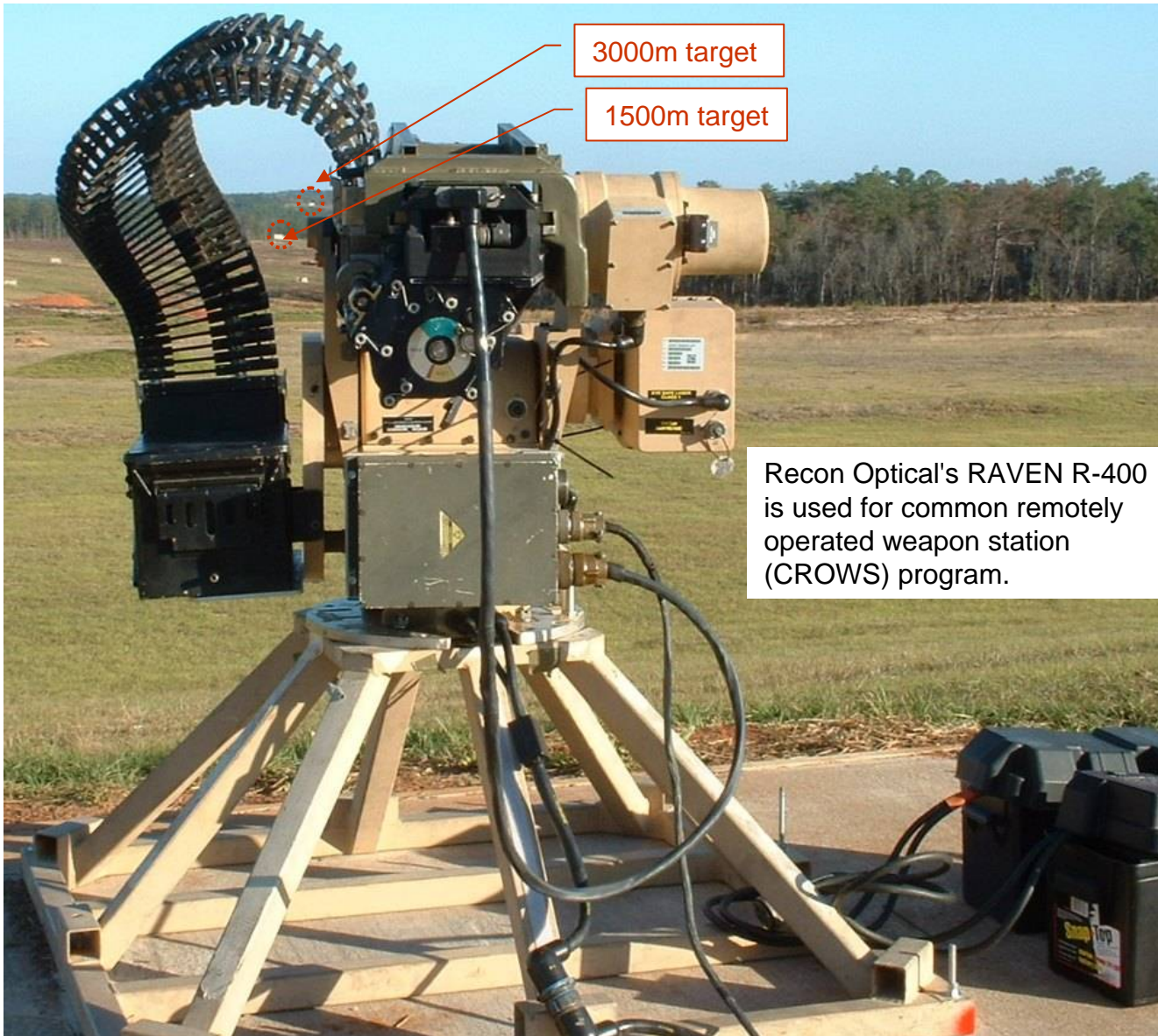
Source: Google Earth

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ATK M230 LF Gun / ROI Raven system used at Ft. Rucker



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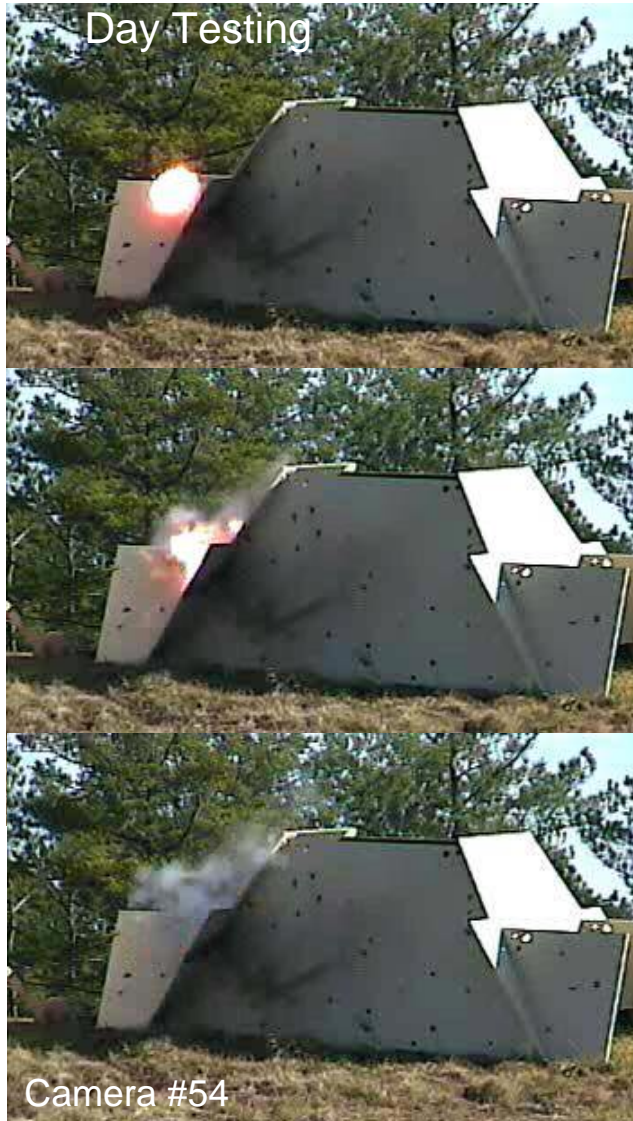
Recon Optical's RAVEN R-400 is used for common remotely operated weapon station (CROWS) program.



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Example of Steel Impact – Day and Night Testing

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A prototype spotter charge for the 30x113mm LW30mm Ammunition family was evaluated against multiple target media and ranges of trajectory

Modeling tools were used for analysis of mass properties, aeroballistic performance, stress analysis and impact thermal stress.

- PRODAS modeling provided ballistic match that was verified with radar tracking in ATK test.
- CTH hydrocode modeling indicated that predicted reaction of spotter material on ground impact would be marginal depending on impact angle and velocity.
- ANSYS stress analysis modeling provided design safety that was verified in structural integrity ballistic tests.

Demonstration testing conducted at Ft. Rucker tracked with the results from ATK testing:

- Reliable visible reaction when impacting Steel target, day and night at 1500m, and night at 3000m. Day impact at 3000 not available.
- Impact on Plywood target showed delay reaction behind target; at times was evident and scored by pilot as sufficiently visible allowing for adjustment. More evident at night.
- Limited frequency / Marginal short duration visible day / night when impacting ground at 1500m.
- 3000m testing did not reliably impact visible target area due to drift from cross winds (PRODAS)

Further development efforts on hold pending government evaluation of the demonstration testing and updated User need assessment.

Acknowledgements



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ATK - ABL

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ATK -ATPG Test

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Chris Stewart
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Matt Berg

ATK - AW

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Wayne Hierlmaier
Mark Krueger
Dave Fehr

ATK - AW

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Dave Darden

Recon Optical

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