MULTI-ROLE ARMAMENT & AMMUNITION SYSTEM (MRAAS) CANNON

Providing America Advanced Armaments for Peace and War

A PRESENTATION TO THE

NATO RESEARCH AND TECHNOLOGY AGENCY (RTA)

AVT – 108

WEAPONS INTEGRATION WITH LAND AND AIR VEHICLES – LAND SESSION

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
01 JUN 2004	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Multi-Role Armament & Ammunition System (MRAAS) CANNON	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **ARDEC**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM201999., The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**27**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

BACKGROUND

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- FUTURE COMBAT SYSTEM (FCS): “THE FUTURE COMBAT SYSTEMS WILL BE A MULTI-FUNCTIONAL, MULTI-MISSION RE-CONFIGURABLE SYSTEM OF SYSTEMS TO MAXIMIZE . . . TRANSPORTABILITY AND COMMONALITY OF MISSION ROLES INCLUDING DIRECT AND INDIRECT FIRE, AIR DEFENSE, RECONNAISSANCE, TROOP TRANSPORT, . . .
- MRAAS: MULTI-ROLE ARMAMENT SYSTEM IS TECH BASE DEVELOPMENT OF AN ARMAMENT SYSTEM TO PROVIDE BOTH DIRECT AND INDIRECT FIRE CAPABILITIES FOR FCS
- BLOS: BEYOND LINE OF SIGHT, LOS: LINE OF SIGHT
- STO: SCIIENCE & TECHNOLOGY OBJECTIVE
- TRL: TECHNOLOGY READINESS LEVEL
- MAST: MCS AMMUNITION SYSTEM TECHNOLOGY
- ETI/ETC: ELECTROTHERMAL IGNITION/ELECTROTHERMAL-CHEMICAL

PROGRAM OBJECTIVES
FCS-MRAAS

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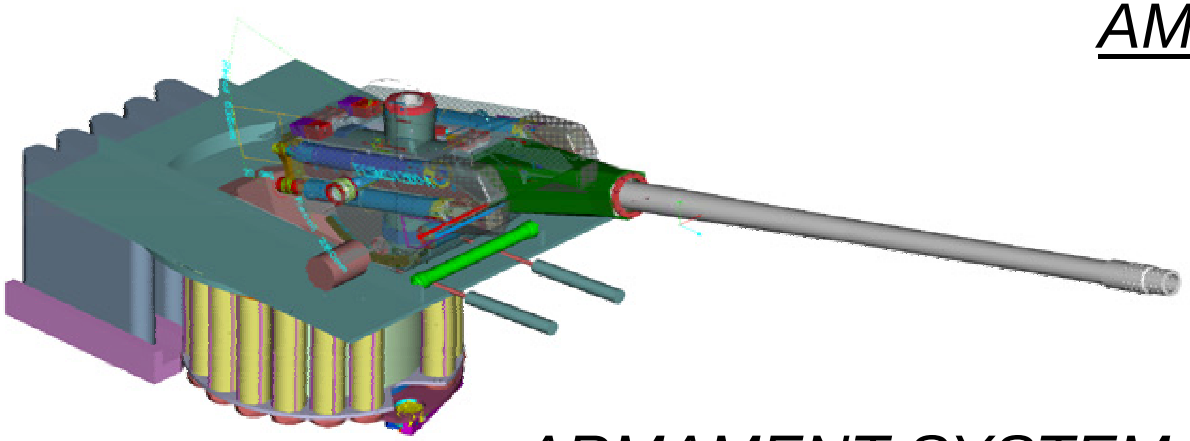
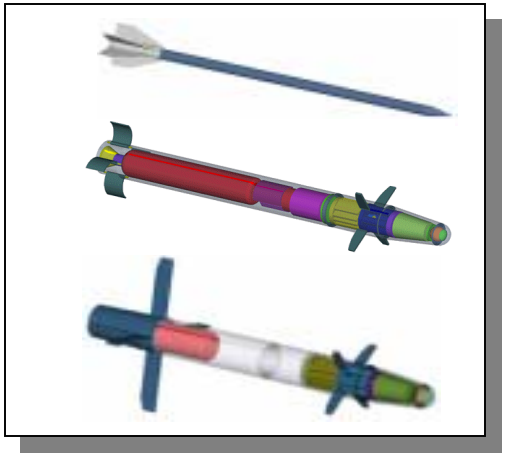
- ASSIST THE U.S. ARMY IN DETERMINING MATERIAL NEEDS AND ASSOCIATED REQUIREMENTS FOR ITS FUTURE COMBAT SYSTEM (FCS)
- IDENTIFY AND ADVANCE PACING ARMAMENT & AMMUNITION TECHNOLOGIES THAT WILL HELP MEET FCS MATERIAL NEEDS AND REQUIREMENTS

AMMUNITION SUITE





ARMAMENT SYSTEM

SYSTEM DESIGN - AMMUNITION

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- **DEVELOPED A CASED TELESCOPING APPROACH (BY PICATINNY & ARMTEC)**
  - **ALLOWS EASY AUTOLOADING & HANDLING**
  - **NO NEED FOR ZONING SINCE SMART PROJECTILE & GUN POINTING WILL ALLOW FOR RANGE CORRECTION AND MRSI MISSIONS.**

SYSTEM DESIGN - AMMUNITION

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- **ALSO EXAMINED INNOVATIVE INTEGRATION APPROACHES (PICATINNY & ARMTEC)**
  - **COMBINE PACKAGING AND CARTRIDGE INTO A RECYCLABLE, AUTOLOADABLE, ENVIRONMENTAL UNIT**
  - **OPTIONAL APPROACH WOULD BE TO UTILIZE A COMBUSTIBLE CASE AND SEPARATE CONTAINER**
  - **SEALS INTEGRATED WITH END CAPS**

MRAAS - OVERALL CONCEPT

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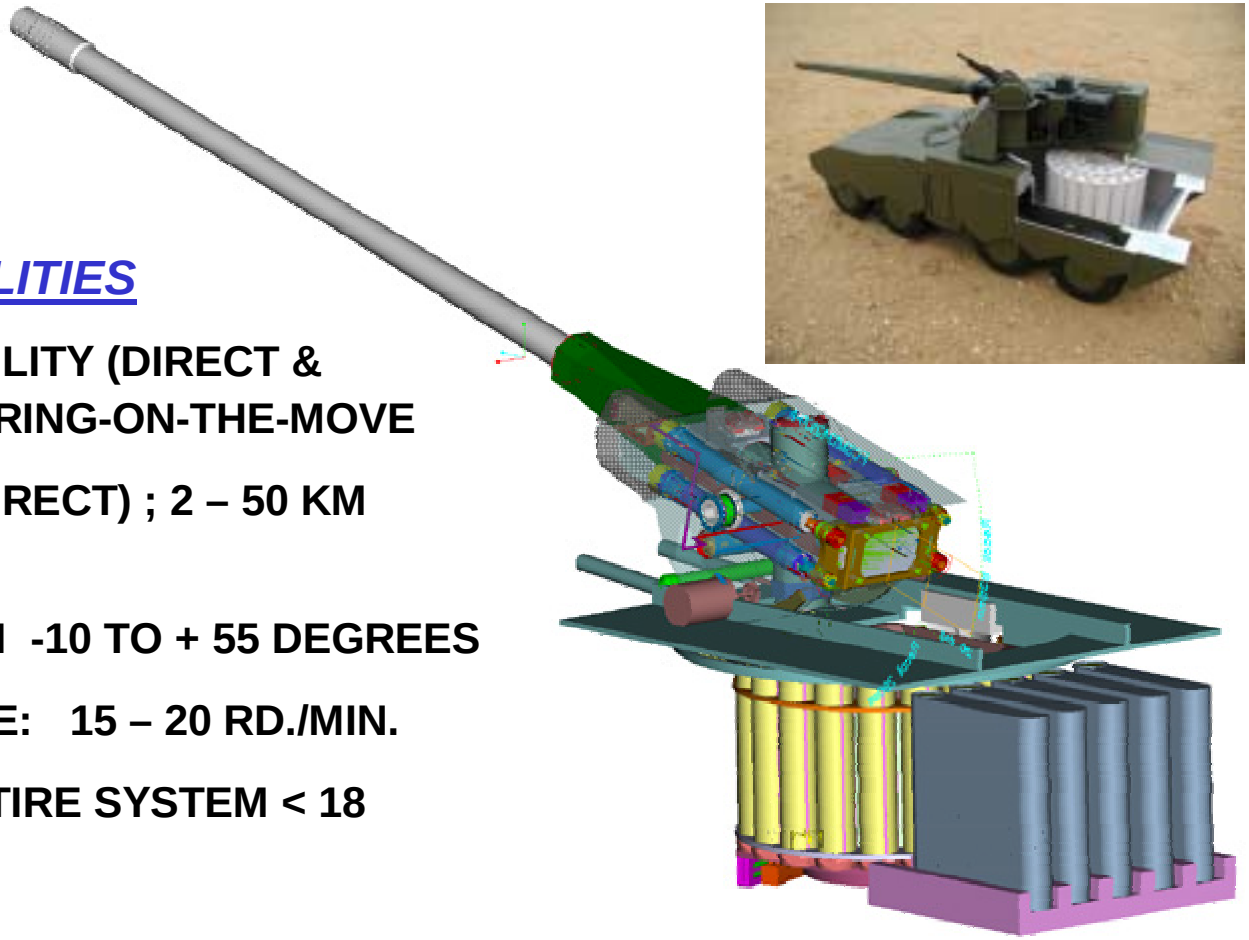

KEY SYSTEM CAPABILITIES

- **MULTI-ROLE CAPABILITY (DIRECT & INDIRECT), WHILE FIRING-ON-THE-MOVE**
- **RANGE: 0 - 4 KM (DIRECT) ; 2 – 50 KM (INDIRECT)**
- **CANNON ELEVATION -10 TO + 55 DEGREES**
- **BURST RATE OF FIRE: 15 – 20 RD./MIN.**
- **LIGHTWEIGHT (ENTIRE SYSTEM < 18 TONS)**

SYSTEM DESIGN - OVERALL LAUNCHER

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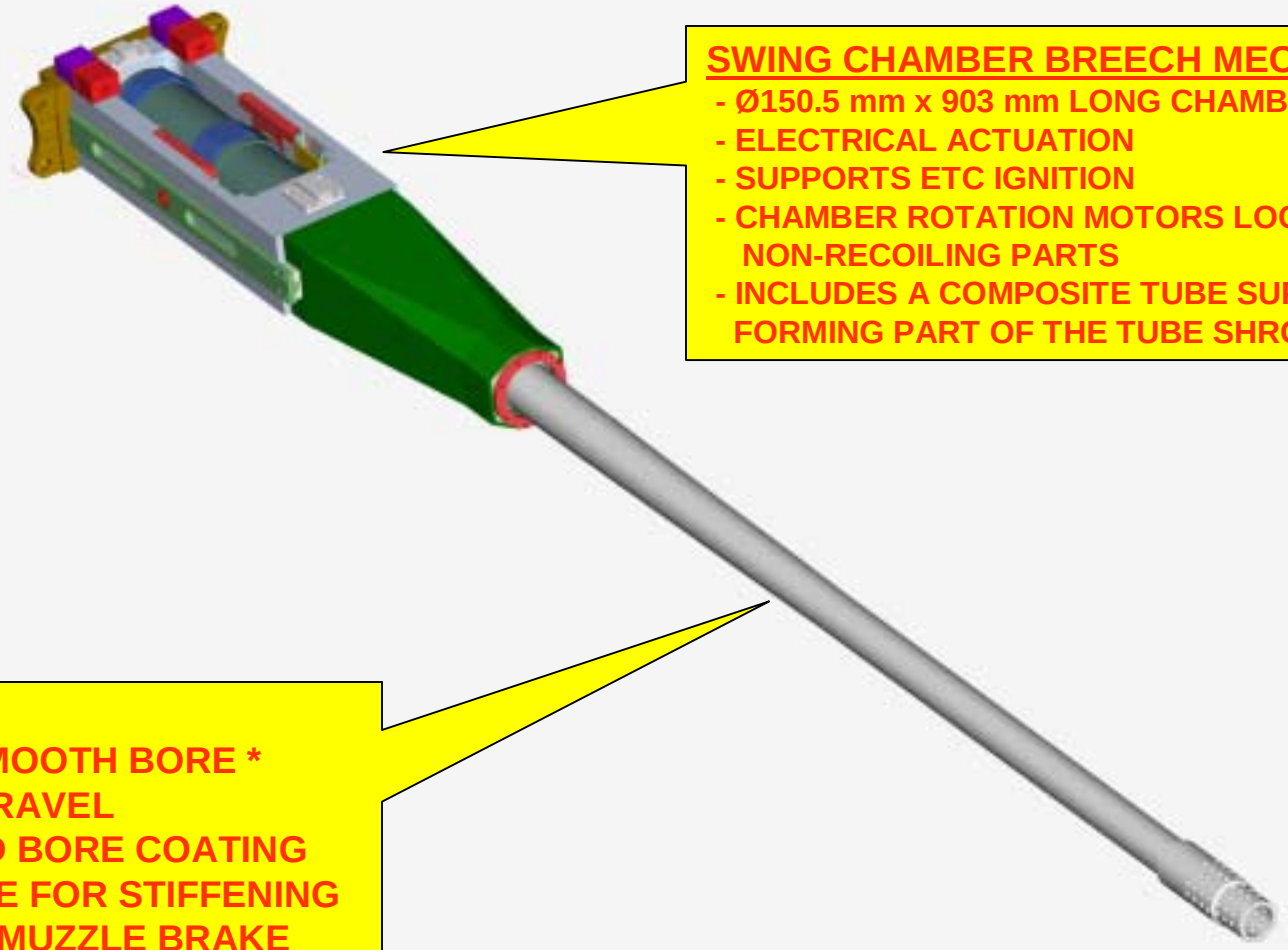

SWING CHAMBER BREECH MECHANISM
- Ø150.5 mm x 903 mm LONG CHAMBER
- ELECTRICAL ACTUATION
- SUPPORTS ETC IGNITION
- CHAMBER ROTATION MOTORS LOCATED ON NON-RECOILING PARTS
- INCLUDES A COMPOSITE TUBE SUPPORT FORMING PART OF THE TUBE SHROUD.

GUN TUBE
- 105 mm SMOOTH BORE *
- 5400mm TRAVEL
- ADVANCED BORE COATING
- COMPOSITE FOR STIFFENING
- INTEGRAL MUZZLE BRAKE

OVERALL SYSTEM CONCEPT

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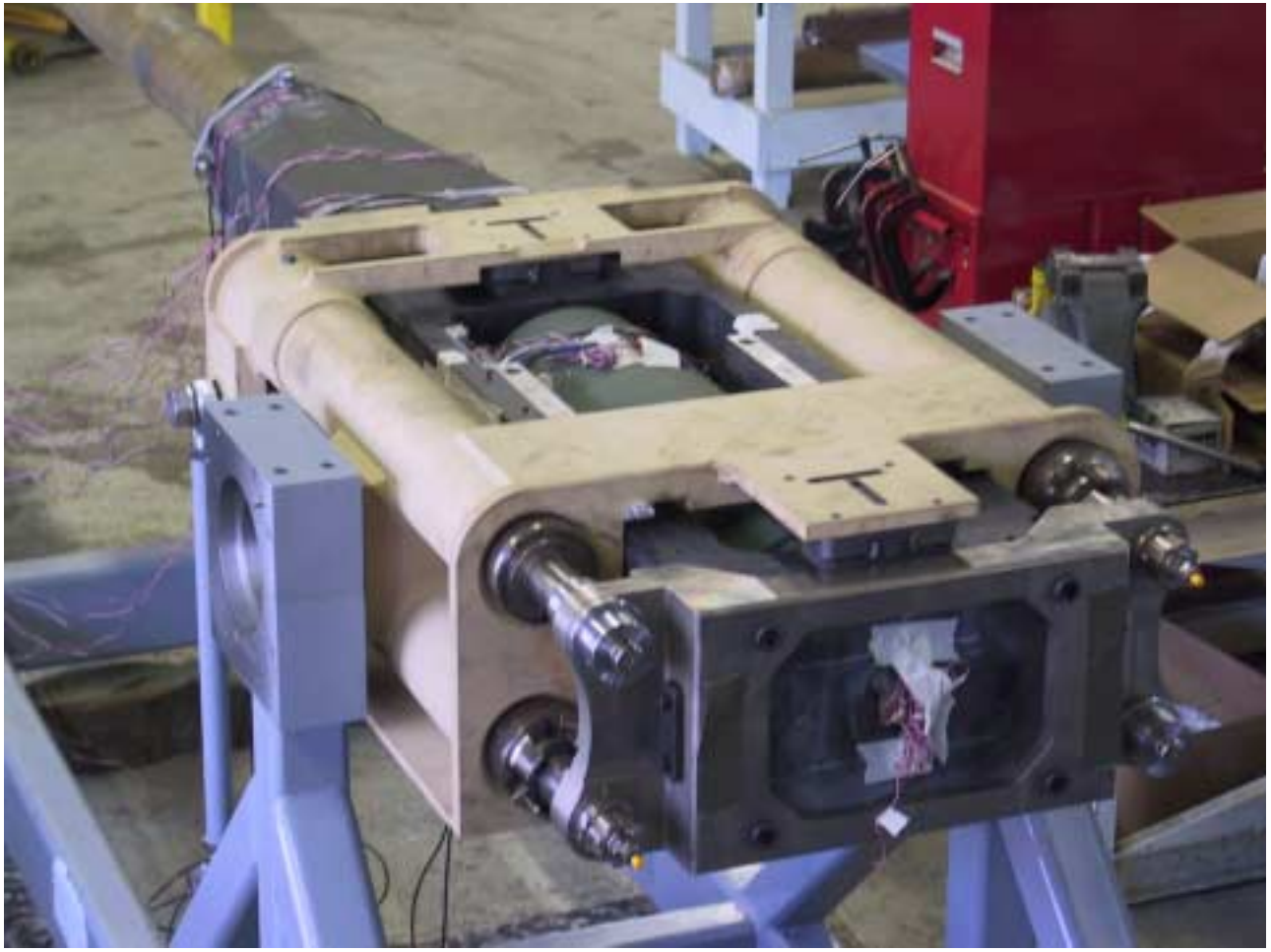

KEY TECHNICAL THRUST
INTEGRAL MUZZLE BRAKE

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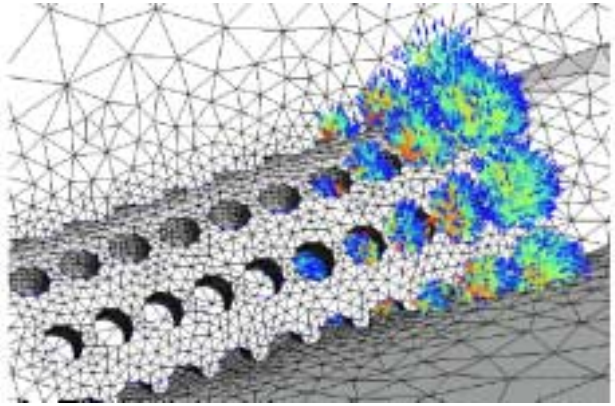
- EXTENSIVE COMPUTATIONAL FLUID DYNAMIC MODELS
- ESTIMATE FORCES AND BLAST FIELDS
- EXAMINED GEOMETRIES TO MINIMIZE EFFECT ON LIGHT VEHICLES
- ALLOW FOR FUTURE DESIGN OF LIGHTWEIGHT SURVIVABILITY SHROUDS



KEY TECHNICAL THRUST
COMPOSITE TUBE SUPPORT

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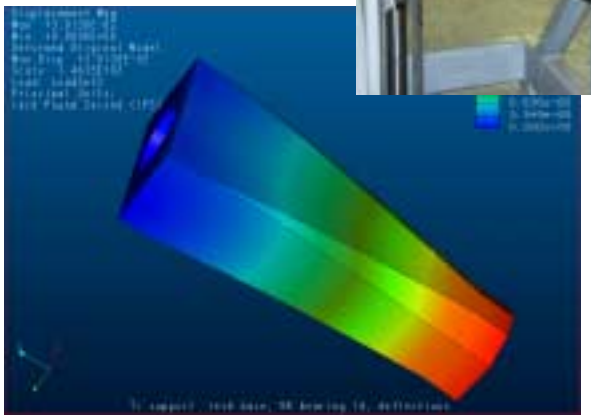
- CONCEPT FOR SUPPORT/STIFFENING THE TUBE
- DIFFERED FROM COMPOSITE TUBE
- UTILIZED TITANIUM END FRAMES AND CARBON FIBER SHELL
- SHAPE WAS OPTIMIZED TO BECOME PART OF FUTURE SURVIVABILITY SUITE
- UTILIZED PATENTED BENET TUBE INTERLOCK THAT ALLOWS TUBE DILATION WITHOUT RESTRICTION.



ASSEMBLY WEIGHT REQUIREMENT 130 LBS - ACTUAL 65 LBS

KEY TECHNICAL THRUST COMPOSITE TUBE

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- 15% WEIGHT REDUCTION
  - SYSTEM LEVEL WEIGHT REDUCTION
  - IMPROVED GUN BALANCE
- IMPROVED DYNAMIC STRAIN MITIGATION
- TUBE STIFFNESS UNCHANGED
  - DESIGN PARAMETERS INDICATE THAT STIFFNESS CAN BE INCREASED WHILE PRESERVING WEIGHT SAVINGS

KEY TECHNICAL THRUST TITANIUM COMPONENTS

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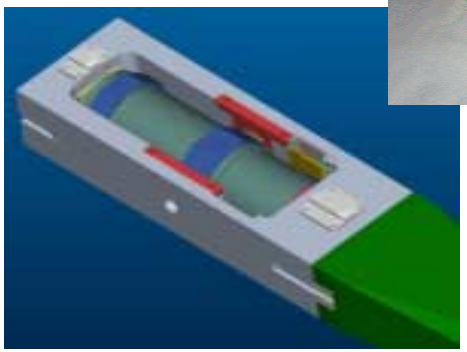
- EXTENSIVE USE OF TITANIUM COMPONENTS TO SAVE WEIGHT.
- INHOUSE TESTING ADDRESSED FATIGUE CHARACTERISTICS OF TITANIUM USED IN STRUCTURAL ELEMENTS
- RAPID PROTOTYPING AND CASTING USED TO SPEED DEVELOPMENT



KEY TECHNICAL THRUST
RECOILING ELECTRICAL COMPONENTS

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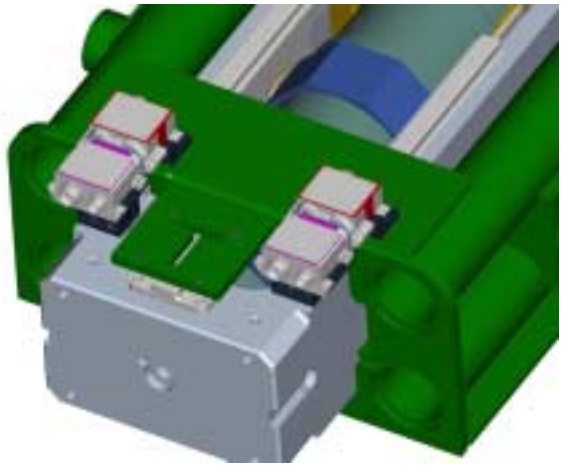
- LEVERAGED MAKE BREAK CONNECTORS DEVELOPED FOR CRUSADER AND EXPANDED THE SENSORS AND ELECTRICAL CAPACITY.
- UTILIZED COMPACT LINEAR MOTORS FOR BREECH SEAL ACTUATION ON RECOILING BREECH
- UTILIZED ROTARY MOTORS TO ADJUST BRAKES FOR VARIABLE RECOIL ON CRADLE



KEY TECHNICAL THRUST
VARIABLE LENGTH RECOIL BRAKES

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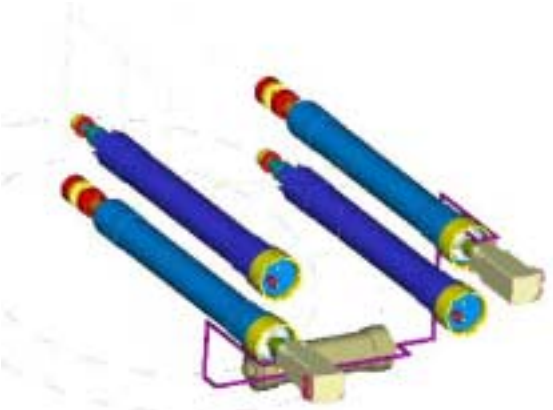
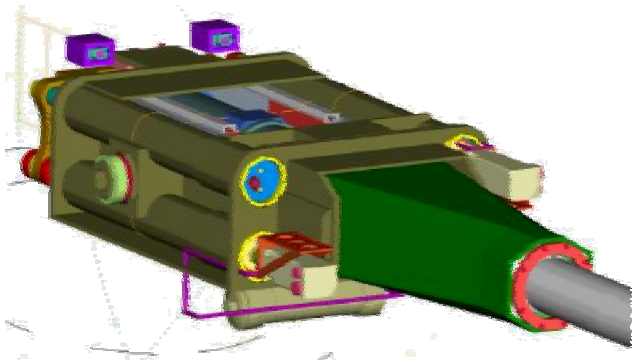
- ROTARY ELECTRIC MOTOR ADJUSTED BRAKES TO VARIABLE LENGTH BASED ON ELEVATION AND AMMUNITION
- INDIRECT FIRE @ -3° TO +55° ELEVATION
- DIRECT FIRE @ -10° TO +20° ELEVATION
- VARIABLE RECOIL (19 & 25 INCHES)
- DEVELOPED AT PICATINNY ARSENAL





KEY TECHNICAL THRUST
HIGH STRENGTH STEEL

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- **NEW HIGH STRENGTH STEEL USED**
  - **10+% INCREASE IN YIELD (165 –> 190 KSI)**
  - **NO DECREASE IN TOUGHNESS**
- **FATIGUE TESTING AND ANALYSIS CONDUCTED ON SAMPLES INDICATE GOOD PERFORMANCE IN CANNON ENVIRONMENT**

TECHNICAL COMPATIBILITY (NOT DEMONSTRATED)

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- ELECTROTHERMALCHEMICAL/ELECTROTHERMAL IGNITION (ETC/ETI)
- RAREFACTION WAVE VENTING (RAVEN) COMPATIBLE
- FIRE-OUT-OF-BATTERY (FOOB) COMPATIBLE (TESTS CONDUCTED IN EARLY STAGES)
- HYBRID MUZZLE BRAKE (EXTERNAL AND INTEGRAL)
- SURVIVABILITY/ENVIRONMENTAL SHROUD
- ADVANCED BORE COATINGS

EXTENSIVE MODELING AND SIMULATION

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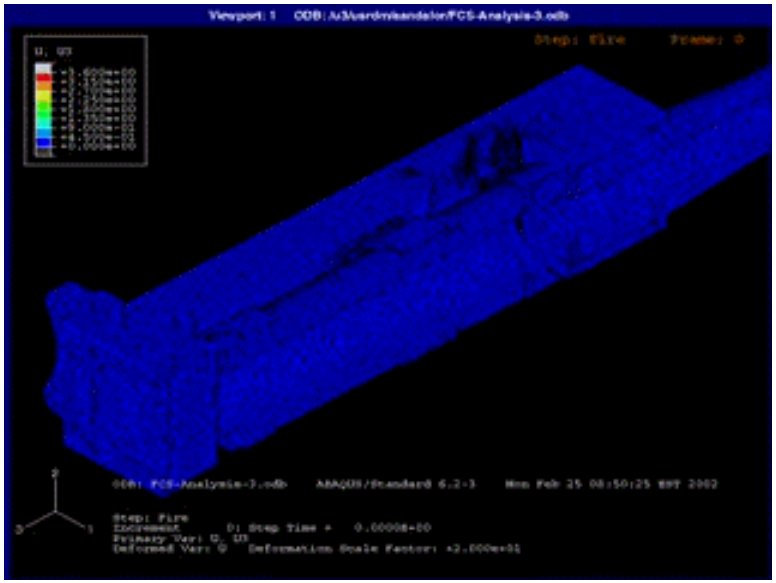
- SHORTENED DEVELOPMENT BY 2-3 YEARS
- MODELING INCLUDED:
  - FEA OF ALL PRESSURE VESSEL COMPONENTS AND MOUNT STRUCTURE
  - NUMERICAL AND FLUID DYNAMICS OF MUZZLE BRAKE
  - MATLAB SYSTEM MODELING OF SWING CHAMBER DYNAMICS
  - NUMERICAL ANALYSIS OF BRAKE AND RECUPERATOR MODELS



EXTENSIVE SUB COMPONENT TESTING

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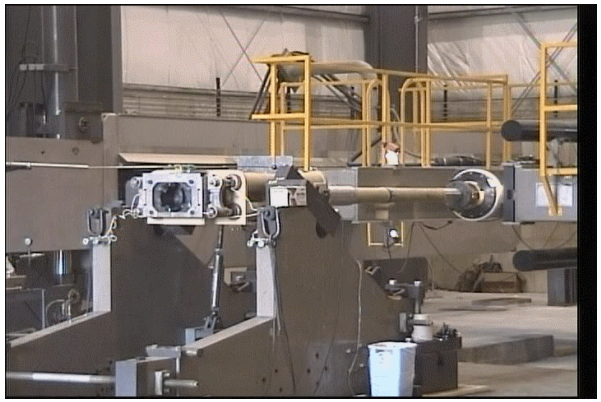
- COMPLEMENTED MODELING BY VALIDATING KEY RISK ELEMENTS
- TESTING INCLUDED:
  - CYCLING BREECH TO CONFIRM MECHANICAL ELEMENTS AND SOFTWARE
  - PRESSURE TESTING SEALS IN FIXTURES
  - DEFLECTION OF TUBE UNDER LOAD
  - CYCLING MOUNT SYSTEM IN GYMNASTICATOR



TESTING AND MODELING GREATLY REDUCED RISK AND ACCELERATED DEVELOPMENT

- FCS-MRAAS LAUNCHER FIRING DEMO – SPRING ’03
- 11 ROUNDS FIRED AT ABERDEEN PROVING GROUNDS
- BOTH DIRECT AND INDIRECT FIRE MODE DEMONSTRATED

TEST FIRINGS IN DIRECT MODE

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- **OVER 90 CHANNELS OF DATA COLLECTED**
- **MUZZLE VELOCITY AND PEAK PRESSURE PREDICITONS CONFIRMED DURING TEST**

TEST FIRING IN INDIRECT MODE

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- CONFIRMED PROJECTED MUZZLE VELOCITY AND RANGE
- TUBE DEFLECTION AND WHIP EXAMINED
- BLAST OVERPRESSURE FIELD MEASURED

TEST RESULTS – BREECH SIDE STRAIN

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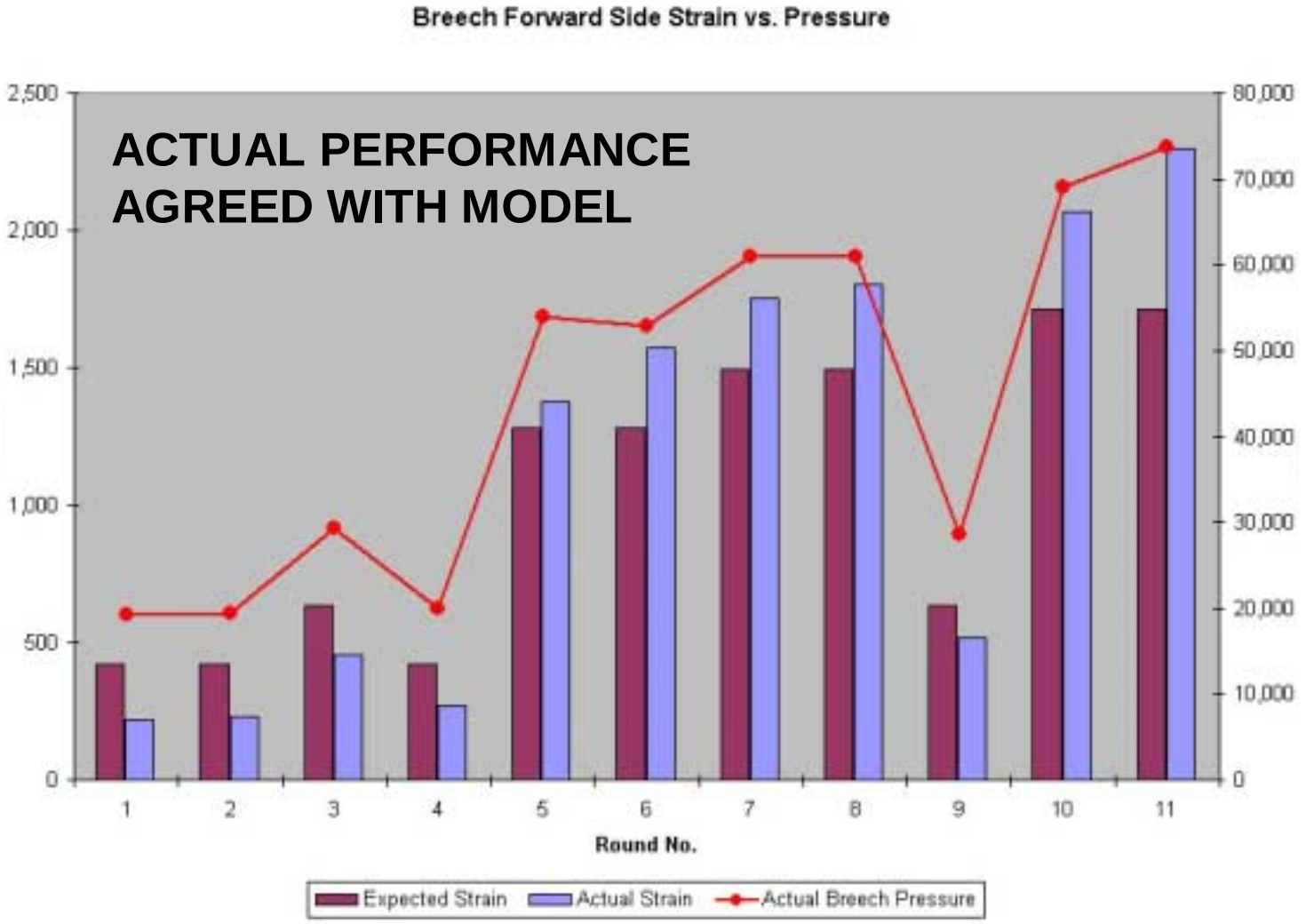

TEST RESULTS – BREECH REAR STRAIN

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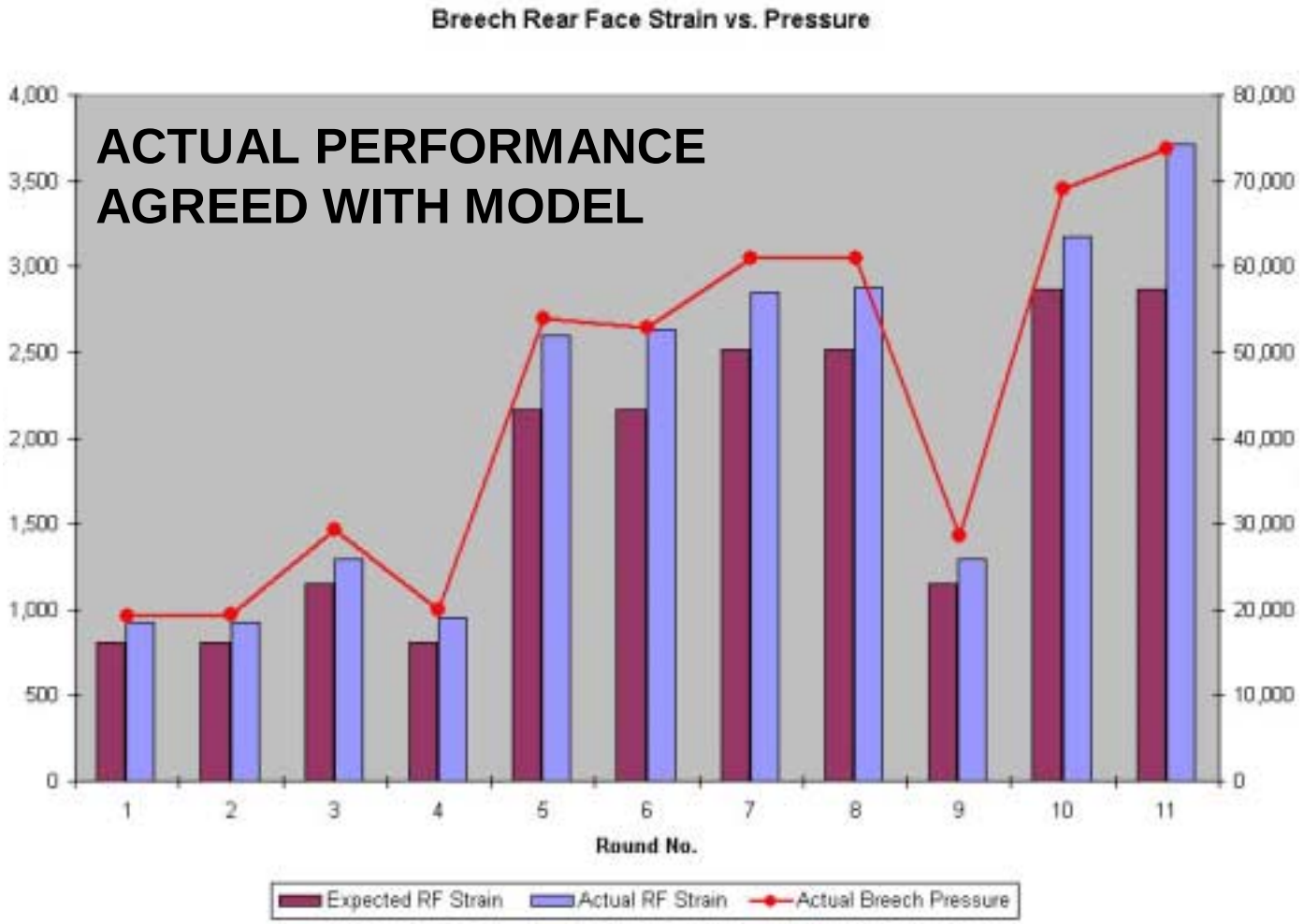

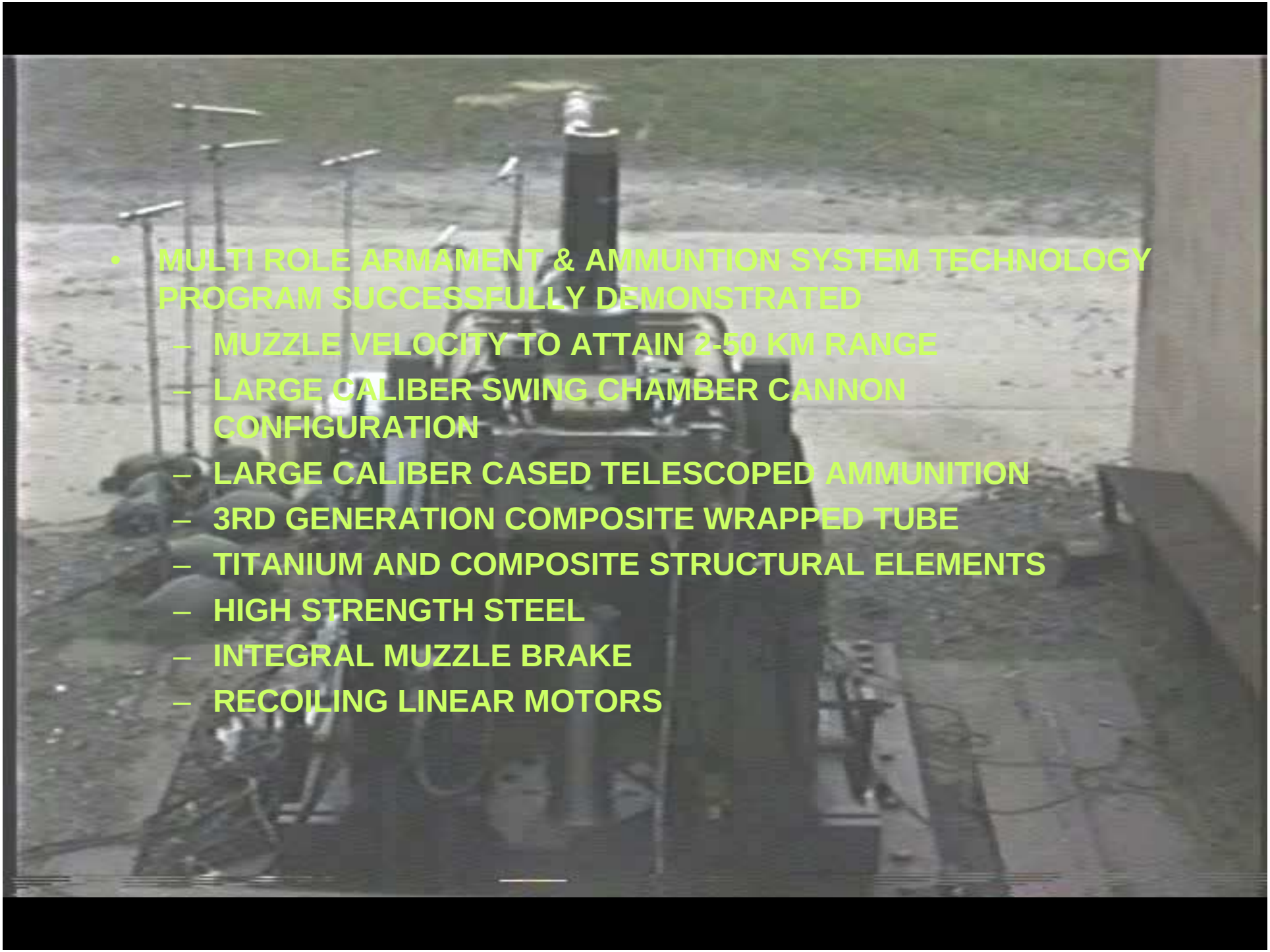

- MULTI ROLE ARMAMENT & AMMUNTION SYSTEM TECHNOLOGY PROGRAM SUCCESSFULLY DEMONSTRATED
  - MUZZLE VELOCITY TO ATTAIN 2-50 KM RANGE
  - LARGE CALIBER SWING CHAMBER CANNON CONFIGURATION
  - LARGE CALIBER CASED TELESCOPED AMMUNITION
  - 3RD GENERATION COMPOSITE WRAPPED TUBE
  - TITANIUM AND COMPOSITE STRUCTURAL ELEMENTS
  - HIGH STRENGTH STEEL
  - INTEGRAL MUZZLE BRAKE
  - RECOILING LINEAR MOTORS

Multi-Role Armament & Ammunition System (MRAAS) Cannon

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This paper was received as a PowerPoint presentation without supporting text.

Paper presented at the RTO AVT Symposium on "Functional and Mechanical Integration of Weapons and Land and Air Vehicles", held in Williamsburg, VA, USA, 7-9 June 2004, and published in RTO-MP-AVT-108.