



**MULTI-ROLE ARMAMENT & AMMUNITION SYSTEM
(MRAAS)
CANNON**

Providing America Advanced Armaments for Peace and War



**A PRESENTATION TO THE 39TH
GUNS & AMMO SYMPOSIUM**

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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: SCIENCE & TECHNOLOGY OBJECTIVE**
- **TRL: TECHNOLOGY READINESS LEVEL**
- **MAST: MCS AMMUNITION SYSTEM TECHNOLOGY**
- **ETI/ETC: ELECTROTHERMAL IGNITION/ELECTROTHERMAL-CHEMICAL**



PROGRAM OBJECTIVES

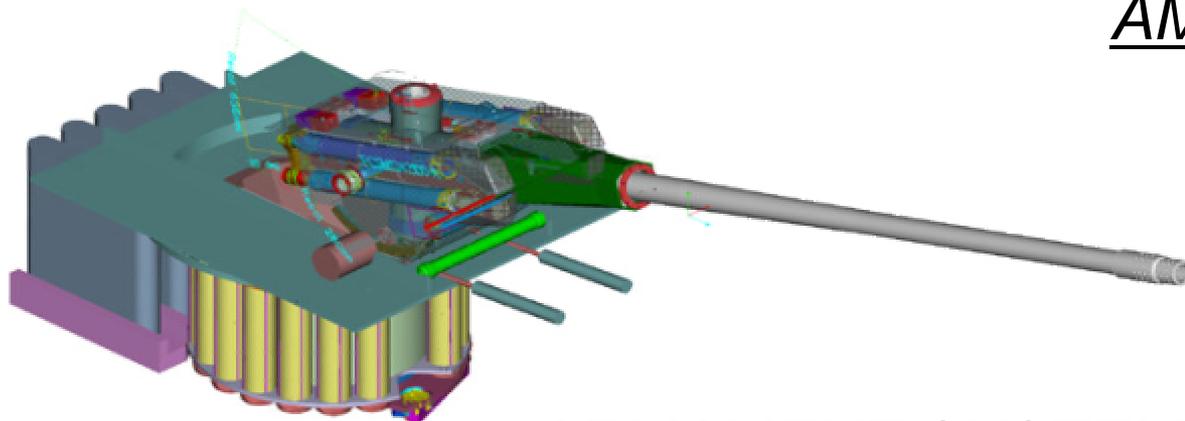
FCS-MRAAS



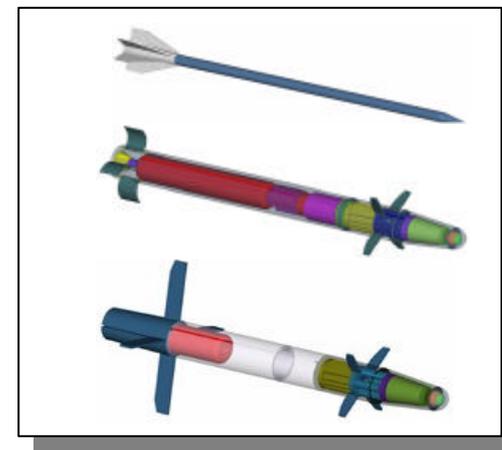
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- ASSIST THE U.S. ARMY IN DETERMINING MATERIAL NEEDS AND ASSOCIATED REQUIREMENTS FOR ITS FUTURE COMBAT SYSTEM (FCS)
- IDENTIFY AND ADVANCE PACING ARMAMENT & AMMUNITION TECHNOLOGIES THAT WILL HELP MEET FCS MATERIAL NEEDS AND REQUIREMENTS

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.**



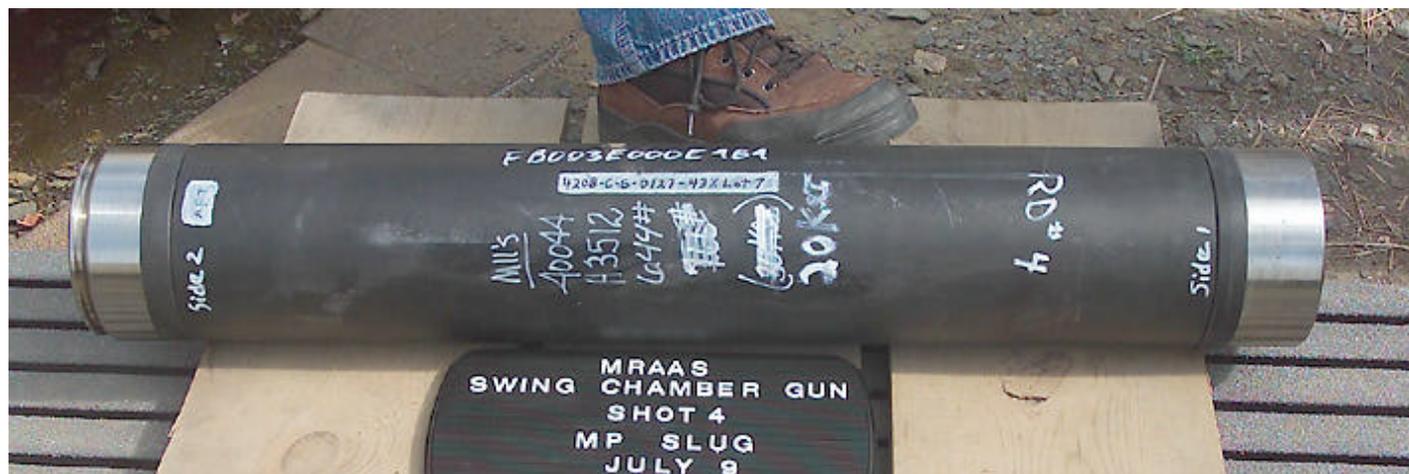


SYSTEM DESIGN - AMMUNITION



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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**





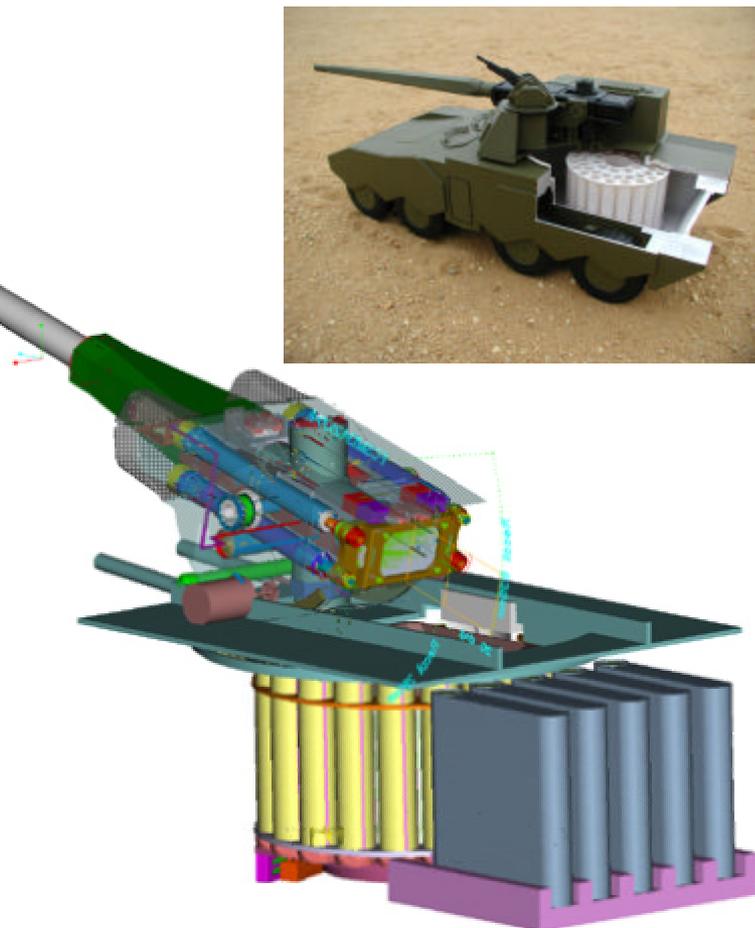
MRAAS - OVERALL CONCEPT



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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)**

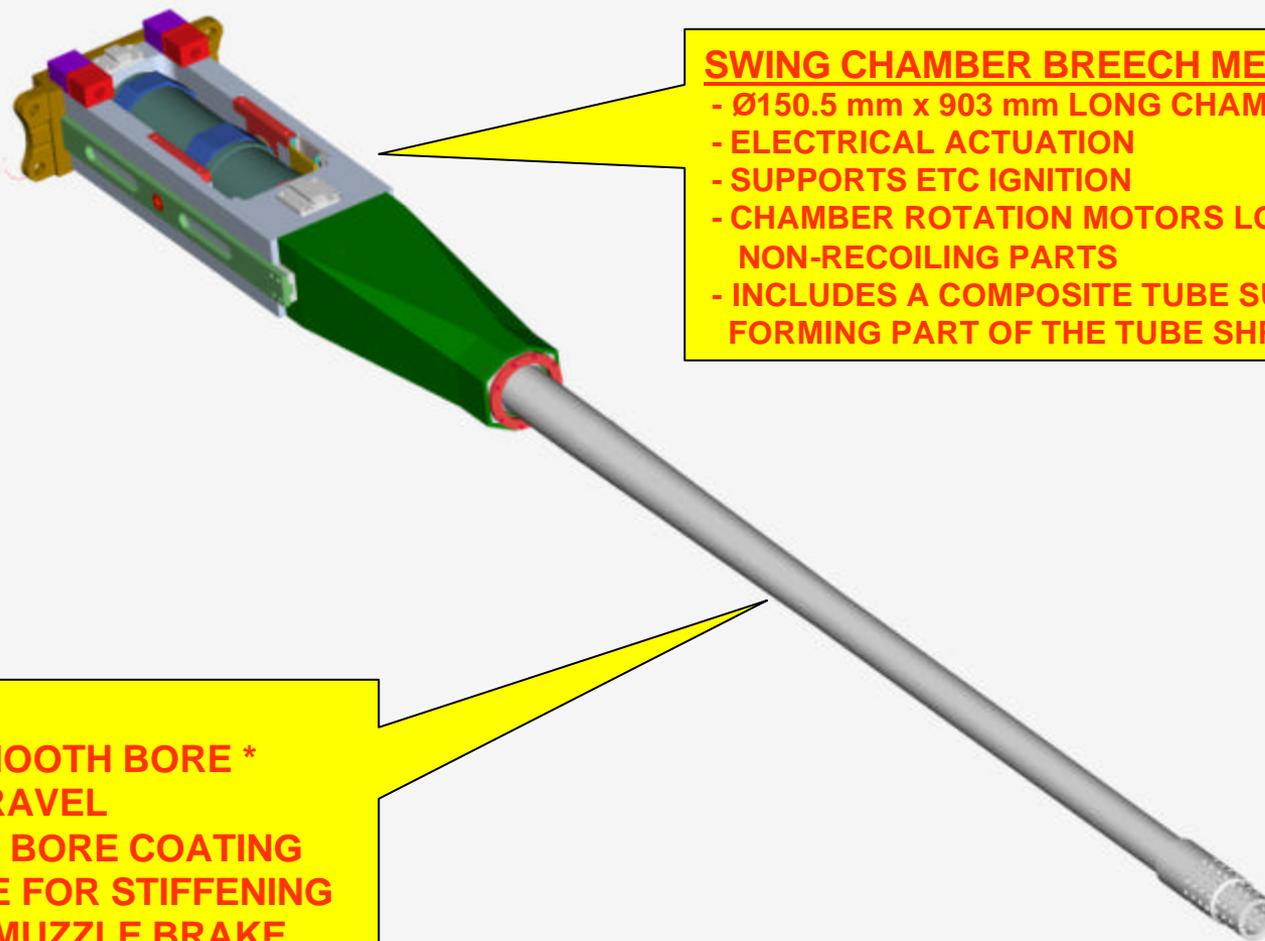




SYSTEM DESIGN - OVERALL LAUNCHER



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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

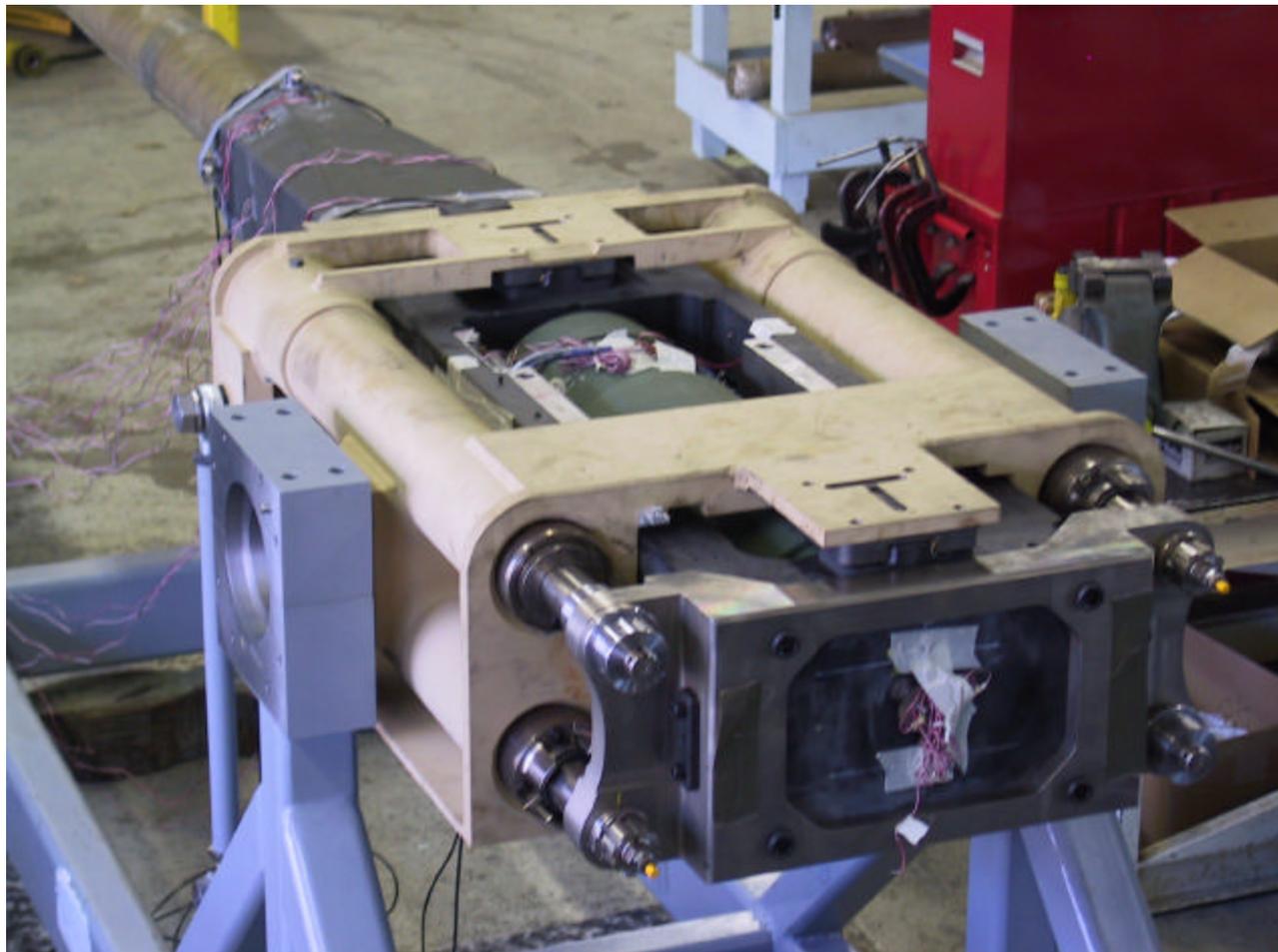
- 105 mm SMOOTH BORE *
- 5400mm TRAVEL
- ADVANCED BORE COATING
- COMPOSITE FOR STIFFENING
- INTEGRAL MUZZLE BRAKE



OVERALL SYSTEM CONCEPT



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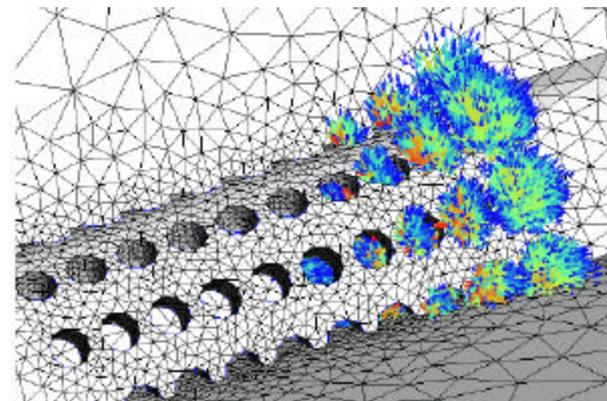


KEY TECHNICAL THRUST INTEGRAL MUZZLE BRAKE



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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



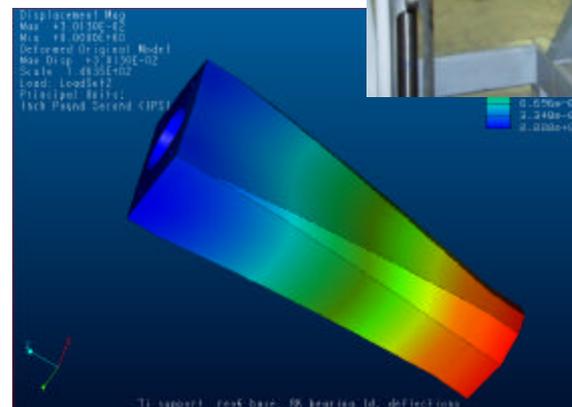


KEY TECHNICAL THRUST COMPOSITE TUBE SUPPORT



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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

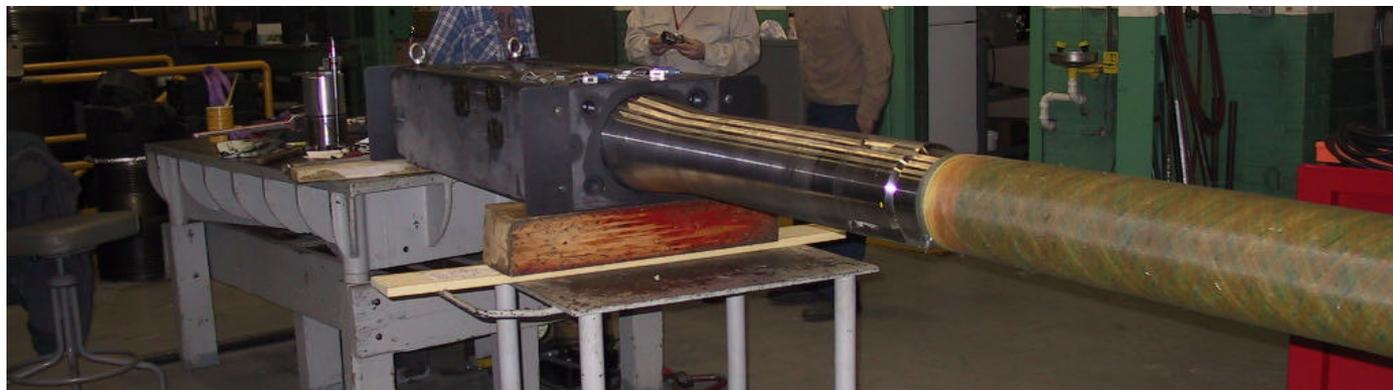


KEY TECHNICAL THRUST COMPOSITE TUBE



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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



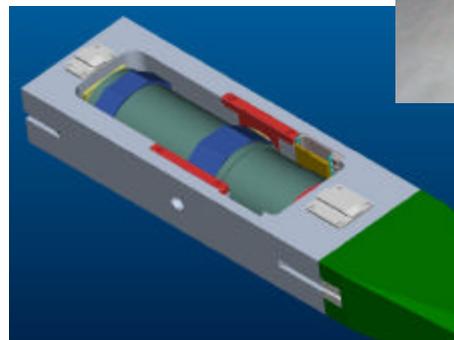


KEY TECHNICAL THRUST TITANIUM COMPONENTS



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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**



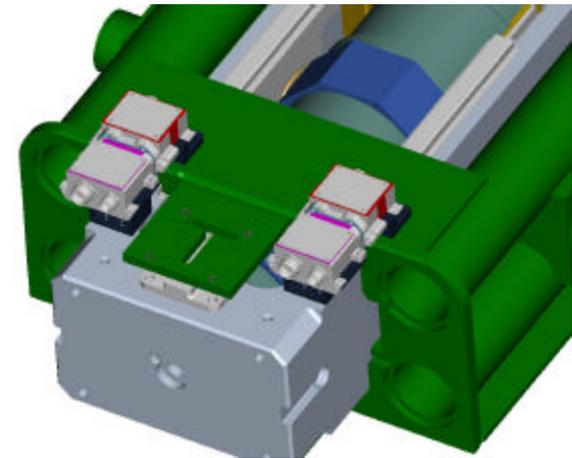


KEY TECHNICAL THRUST RECOILING ELECTRICAL COMPONENTS



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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**



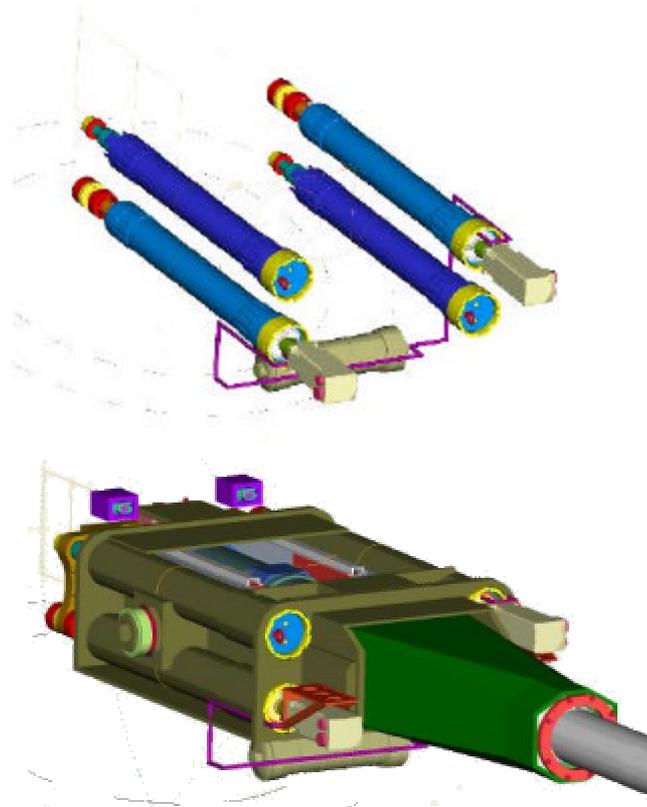


KEY TECHNICAL THRUST VARIABLE LENGTH RECOIL BRAKES



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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**

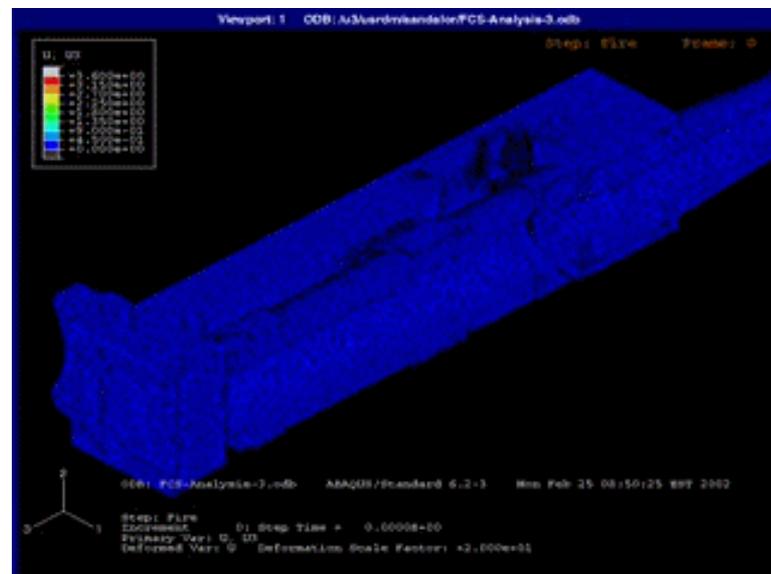


EXTENSIVE MODELING AND SIMULATION



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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**



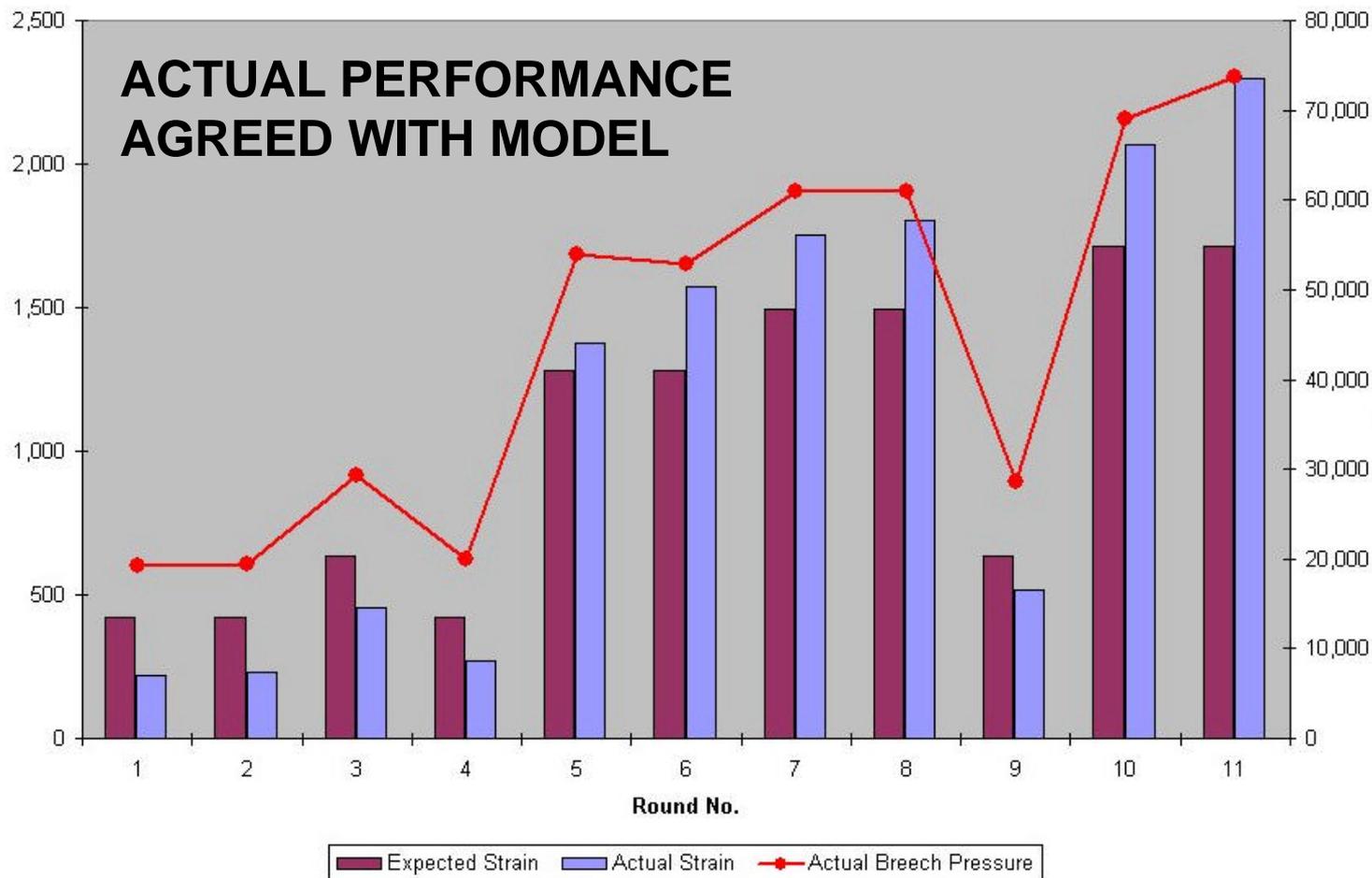


TEST RESULTS – BREECH SIDE STRAIN



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Breech Forward Side Strain vs. Pressure



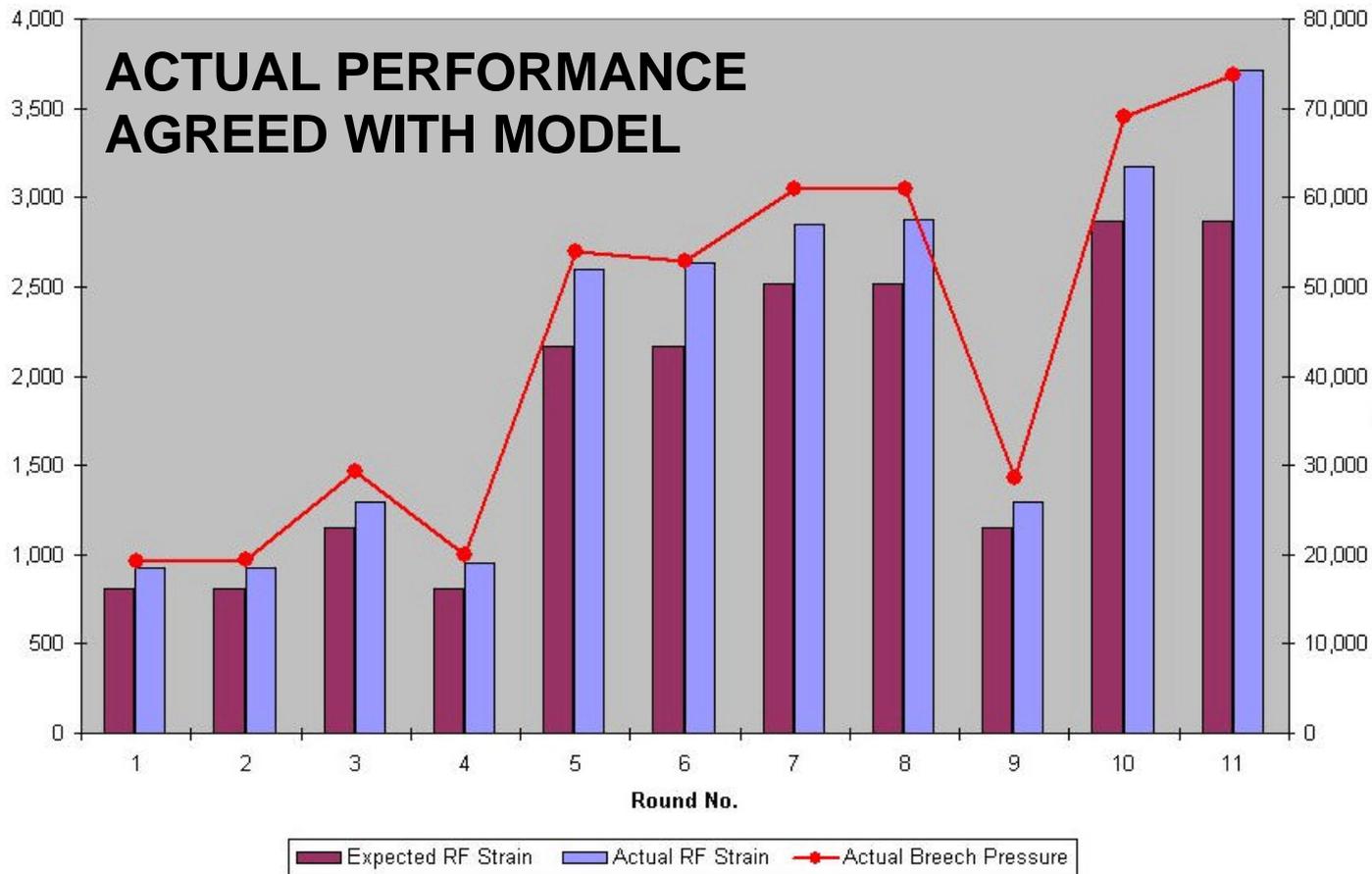


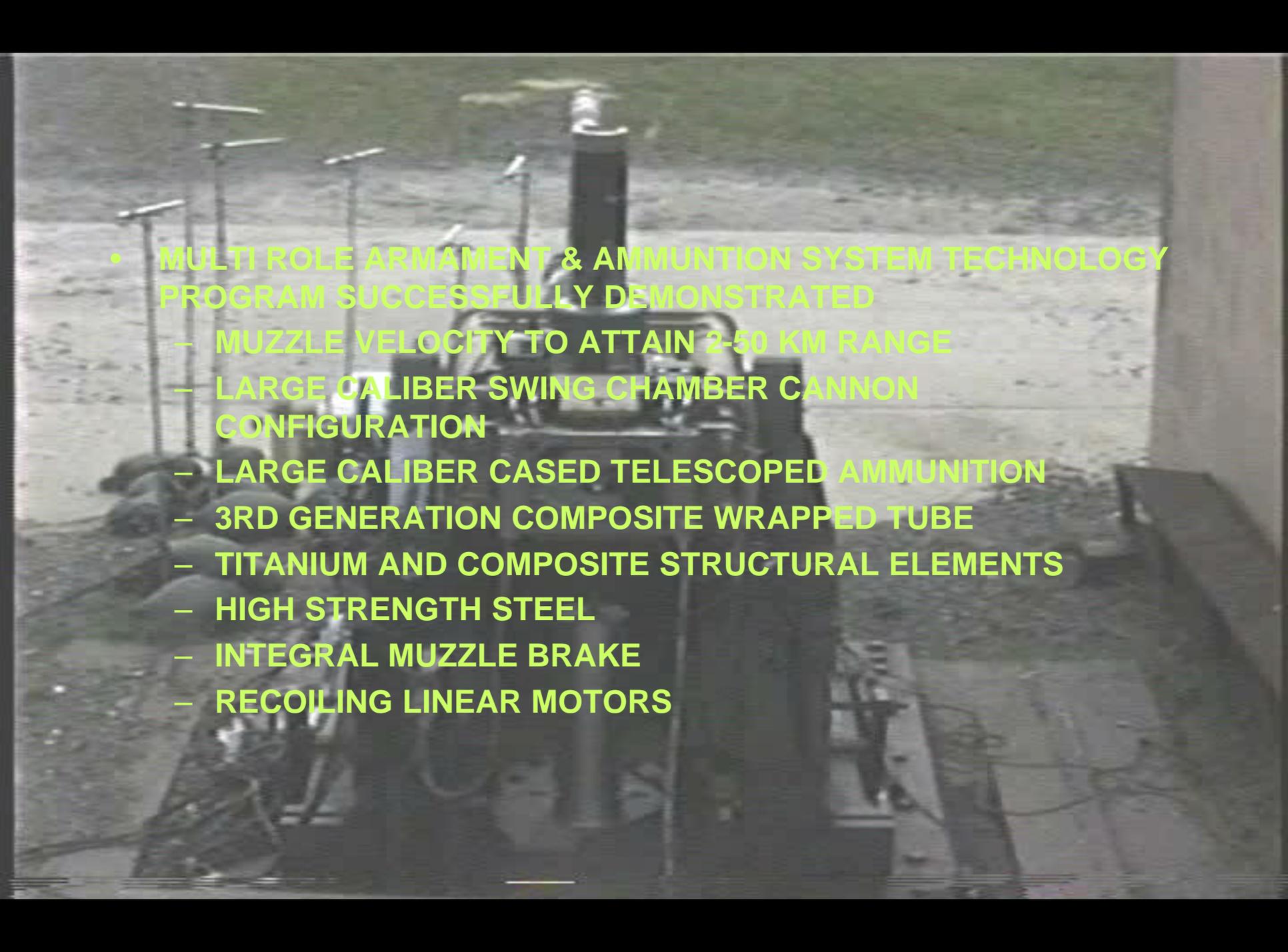
TEST RESULTS – BREECH REAR STRAIN



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Breech Rear Face Strain vs. Pressure



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- **MULTI ROLE ARMAMENT & AMMUNITION 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