Lightweight 81mm Mortar

International Infantry & JSSASA Symposium 17 May 2005

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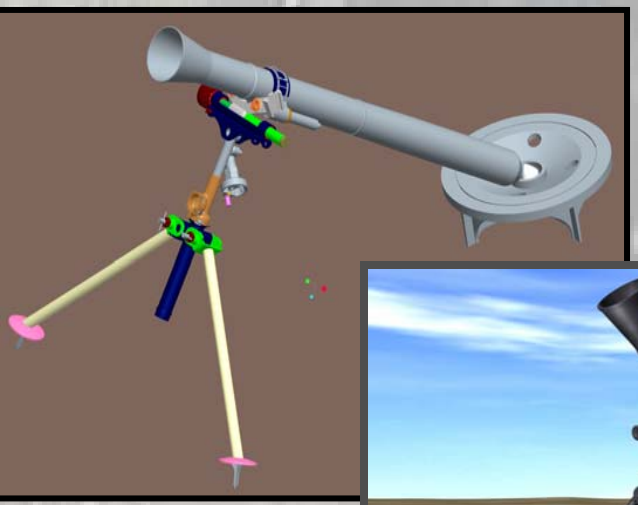

Lightweight 81mm Mortar

The Team

ARDEC

ONR Littoral Combat FNC

Ft. Benning

MARCORSYSCOM

PM Mortars

Lightweight 81mm Mortar

What are the **WARFIGHTER** needs?

- Lighter weight system
  (Eases burden for man transportability)
- Reduced Life Cycle Cost
- Operational commonality among 60, 81 and 120mm mortar weapons
- FCS Dismounted Mortar Requirements

Lightweight 81mm Mortar

What are the barriers to meeting the needs?

- High operating temperatures due to ROF.
  - Durability of lightweight materials.
  - Unprecedented new material applications.
- Bore tube erosion.
- Unpredictable soil conditions.
- Manufacturing techniques and costs.

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How will the barriers be overcome?

- Development and validation of thermal, dynamic, and structural models for accurate analysis.
- Correlation of structural and thermal analysis with live fire data.
- Evaluation/applicability of Nickel-based super alloy (Inconel 718) for mortar tubes.
- Applying the flowform manufacturing process to mortar tube fabrication.
- Evaluation/applicability of carbon fiber reinforced composites for mortar baseplates.
- Application of lightweight materials to new A-frame bipod design.

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Requirements

Capability	Current Capability (Baseline)	Threshold	Objective
• Operational Metrics - Weight	93.25 lb *Cannon 35 lbs Bipod 27 lbs Baseplate 26 lbs*	30% reduction 63.91 lb *Cannon 24.5 lbs Bipod 18.9 lbs Baseplate 18.2 lbs*	40% reduction 54.78 lb *Cannon 21 lbs Bipod 16.2 lbs Baseplate 15.6 lbs*
- Portability	Baseline to be established in portability test.	5% Improvement	10% Improvement
• Affordability Metric	$70,500 unit price	Material Dependant	≤ $70,500 unit price
• TRL	TRL 4	TRL 6	TRL 6
- Tube Life - Rate of Fire - Range	10,000 rounds 30 r/m max, 16 r/m sust 83-5935 m	10,000 rounds 25 r/m max, 16 r/m sust 83-5935 m	≥10,000 rounds 30 r/m max, 16 r/m sust 83-5935 m

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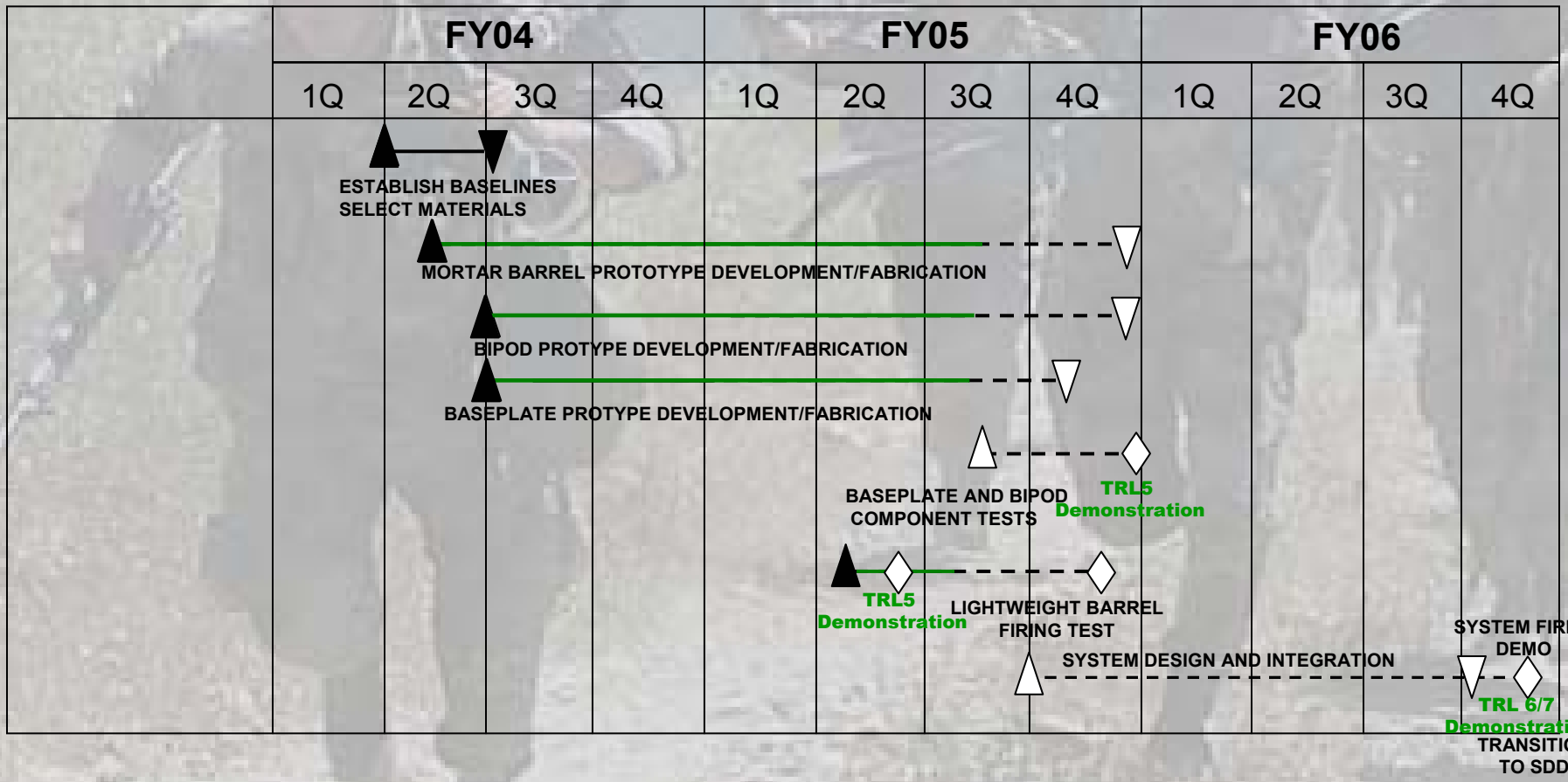
Total Program Milestone Schedule



LEGEND:

Actual Start | Actual End | Milestone

Planned Start | Planned End | Planned Milestone

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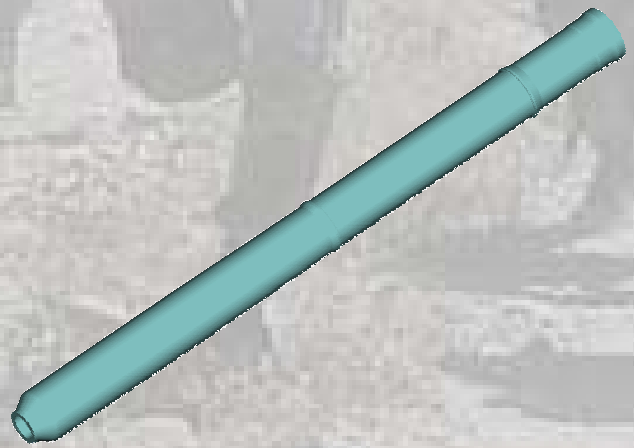
Mortar Cannon - Inconel 718

- Thermal Analysis shows that the tube reaches temperatures above 1000°F.
- Inconel 718 is a Nickel super-alloy that retains high strength at high temperatures.
  - IN718 Yield Strength is 149ksi at 1200°F compared to current mortar steel YS of 105ksi.
  - An IN718 mortar tube can meet the rate of fire requirements without cooling fins.
- IN718 has never been used as a gun tube material.
- Flowforming process will be used to fabricate the tubes at a dramatically reduced cost.

Test Temperature		0.2% Yield Strength		Tensile Strength	
°F	°C	ksi	MPa	ksi	MPa
200	93	170	1172	204	1407
400	204	163	1124	198	1365
600	316	159	1096	195	1344
800	427	156	1076	191	1317
1000	538	155	1069	185	1276
1200	649	149	1027	168	1158
1400	760	110	758	110	758



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CANNON – Flowformed Inconel 718 Cannon Live Fire Testing

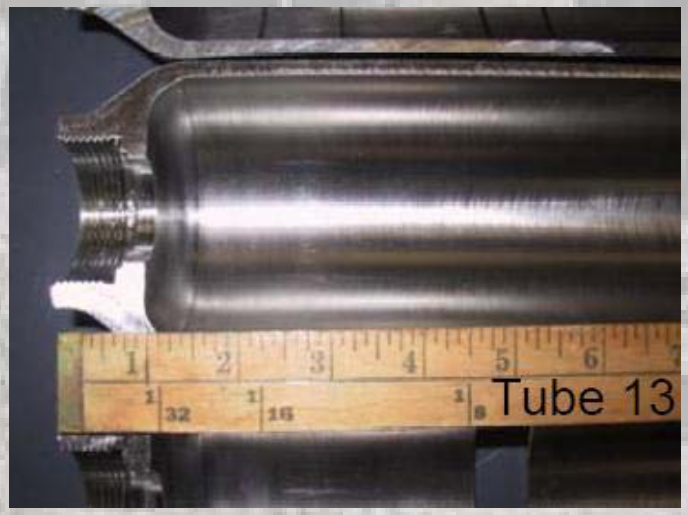
Inconel 718 Tube Test Results, Conclusions and Follow-up

141 rounds were fired from 4 IN 718 mortar tubes.

Prototype mortar tubes were heated to maximum operating temperature

No apparent degradation (erosion/corrosion) of any of the IN 718 tubes was observed. (video bore scope and destructive inspection) Extended wear tests still need to be conducted.

"Nothing was noted to preclude the use of IN718 in future mortar designs."



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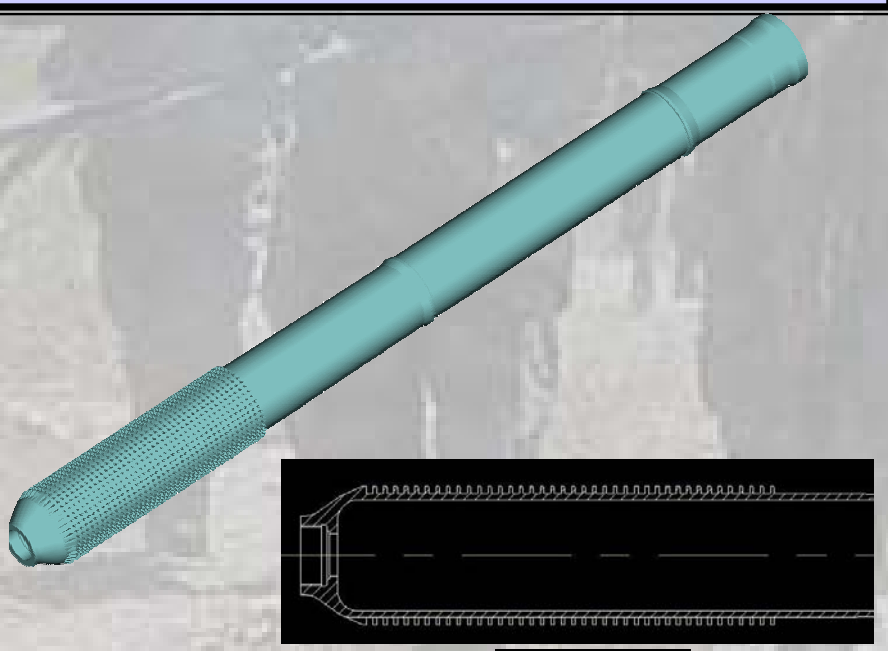
CANNON - High Strain Rate Optimized Cannon

Risk Mitigation (Back-up to IN718)

- High strain rate properties yield strength of current Nb-C steel 163 ksi vs 105 ksi @ 1025°F
- Given this new data, the cannon has been re-optimized and designed.
- 1040°F limitation of current steel necessitates cooling scheme.
- Initial Design weighs 24.9 lbs.(~29% reduction)



FY05 Progress and Plans

- Mid-May expected completion.
- Testing Planned at APG in June.
- Eventual design will be “flow-formable” with final machining of the spines.

	FY05				
MILESTONES	**1QTR**	**2QTR**	**3QTR**	**4QTR**	**1QTR**
Fabrication					
Live Fire Testing					
Analyze Results & Model Verification					

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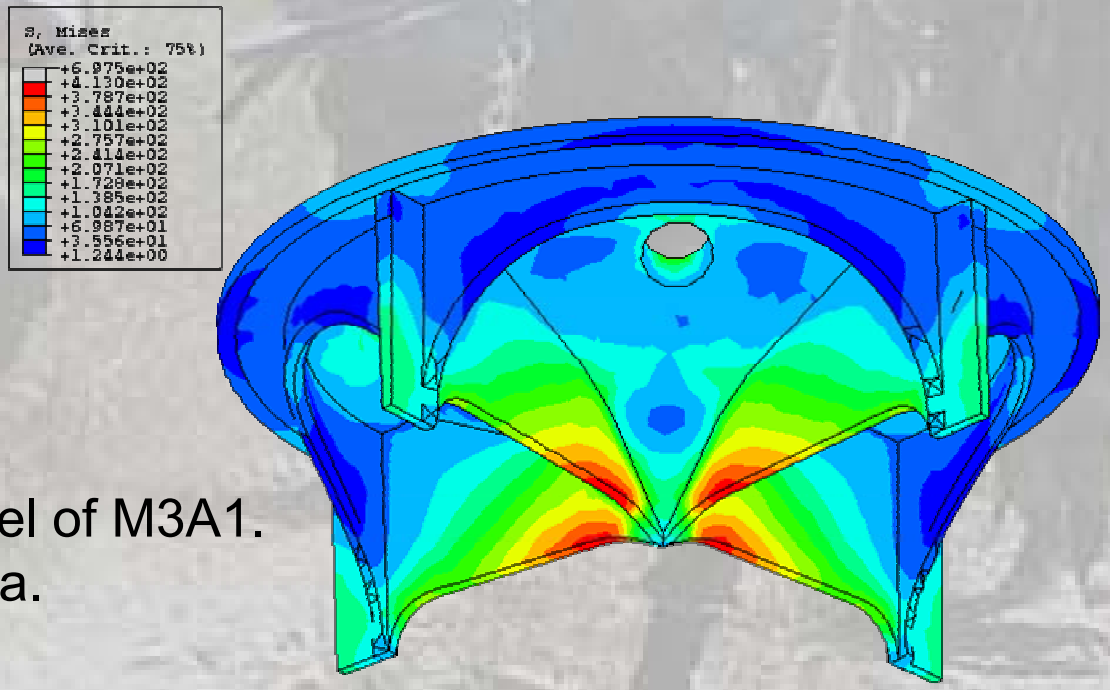
Baseplate Structural Analysis



- Developed finite element model of M3A1.
- Corrolated model with test data.
- Developed two concepts
  - Composite Baseplate Concept
  - Metal Baseplate Concept
- Initial Prototype fabrication to be completed at the end of July.

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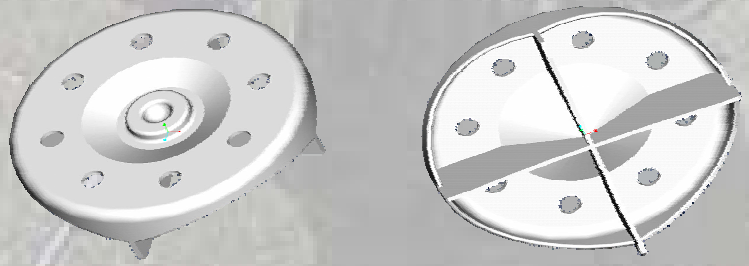
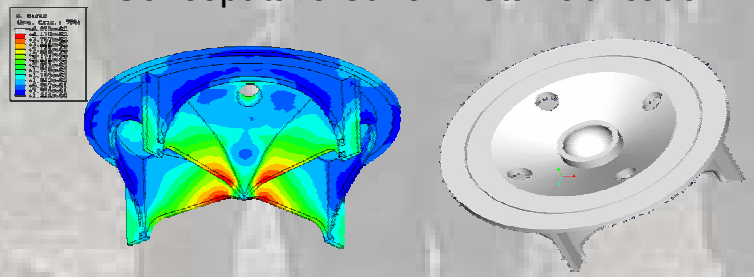
BASEPLATE – Concepts/Materials

Two Baseline Concepts

Concept tailored for composite fabrication



Concept tailored for metal fabrication



Carbon Fiber Reinforced Thermoset Composite Baseplate

40% weight reduction
Initial Prototype July 05
Likely production unit cost $4K

High Strength Forged Aluminum Baseplate

25% weight reduction
Initial Prototype Sept 05
Likely production unit cost under $3K

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BIPOD – Potential Concepts/Materials

Design Drivers

- Analysis of current bipod completed.
- Results indicate tube clamp is the only highly loaded area of bipod.
- Rough handling will be primary design driver of bipod structure (with the exception of clamp.)
- Current K-mount bipod design will be replaced with a A-mount design.
- Commonality with 60mm and 120mm will be stressed.

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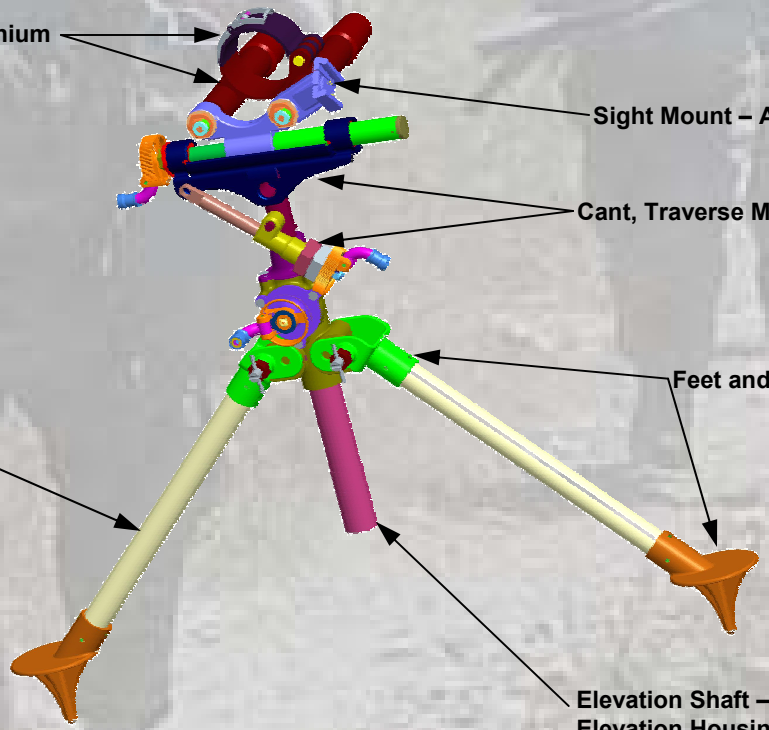
BIPOD – Initial Prototype Material Selection



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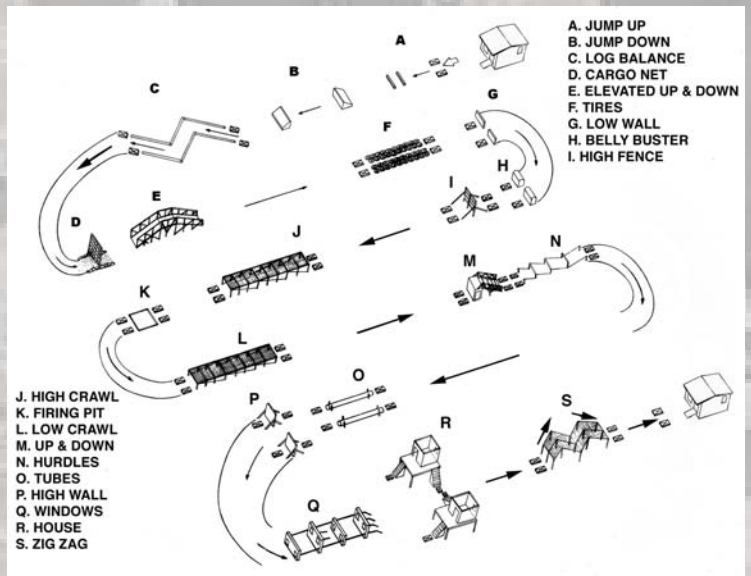
Portability Test

- STO exit criteria requires a 5% to 10% improvement in portability.
- Defining a metric that constitutes such an improvement is nebulous.
- Obstacle course at ARL provides a means to establish a portability metric.
- Time as well as qualitative responses will be used to evaluate improvement.

- Two tests will be conducted, the initial was conducted in April 05, and the final is planned for FY06.
- Results from initial test will establish the portability baseline as well as an initial assessment of representative hardware
- Final test will compare the portability of system demonstration hardware to the M252 and evaluate whether the exit criteria has been met.



Initial test was conducted from Apr 18th to Apr 29th