



# ***Low Cost Course Correction (LC3) For Mortars Information Briefing***

***Presented to  
38<sup>th</sup> Annual Gun, Ammunition and Missiles  
Symposium & Exhibition***

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**GENERAL DYNAMICS**  
Ordnance and Tactical Systems



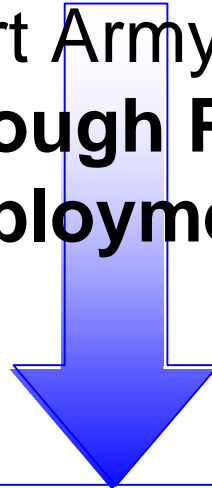


# *PM Mortars*

## *Advanced Munitions Mission*

Develop, Acquire, Produce, Field, Sustain, and Improve **Advanced Mortar Systems**.

Conduct **Strategic Planning** for Mortar Systems, that support Army Transformation from **Tech Base through Production and Deployment**.



**Objective Force**

# *Mortar Evolution: Suppression to Destruction*



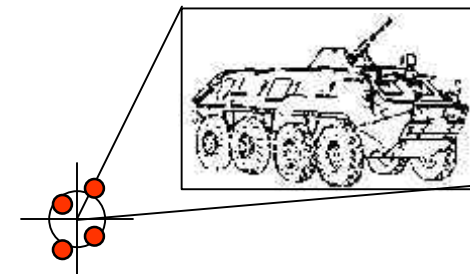
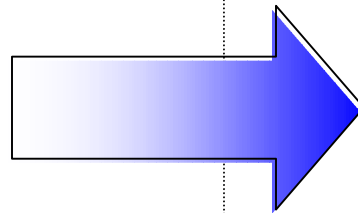
**Today**



## **High Explosive**

- Area Effects
- High Volume Fire
- Defeat Targets in the Open
- Suppress Personnel Under Cover

**Tomorrow**



## **Course Correction**

- Localized Effects
- Less Rounds to Effect Target
- Incapacitate Personnel Under Cover
- Lower Collateral Damage

**LCCC Technology will enhance Battalion Commanders  
Organic Strike Effectiveness**

# 120mm Mortar Munition & System

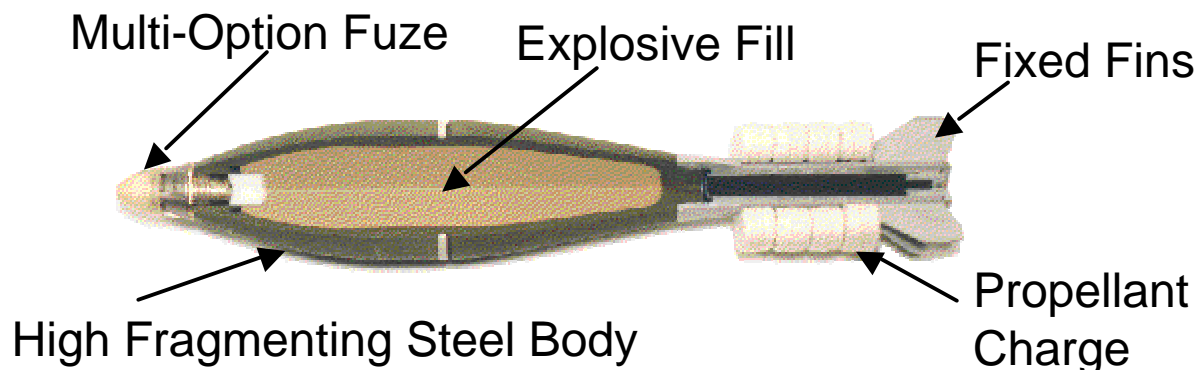


## Today:

M934A1

High Explosive

Max Range 7.2km



## Today:

M120, M121

120mm Smooth Bore, Muzzle Loaded

XM95 & LLDR

Digital Fire Control & New Designator



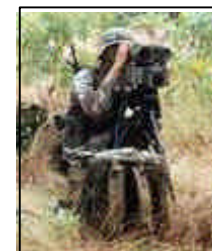
M120



M121



XM95



LLDR

## Tomorrow:

Stryker Mortar Carrier

120mm Smooth Bore, Muzzle Loaded

Objective Force NLOS Mortar

120mm Smooth Bore, Breech Loaded



Stryker  
Mortar Carrier



FCS  
NLOS Mortar



UAVs

# ***Low Cost Course Correction (LC3) for Mortars***

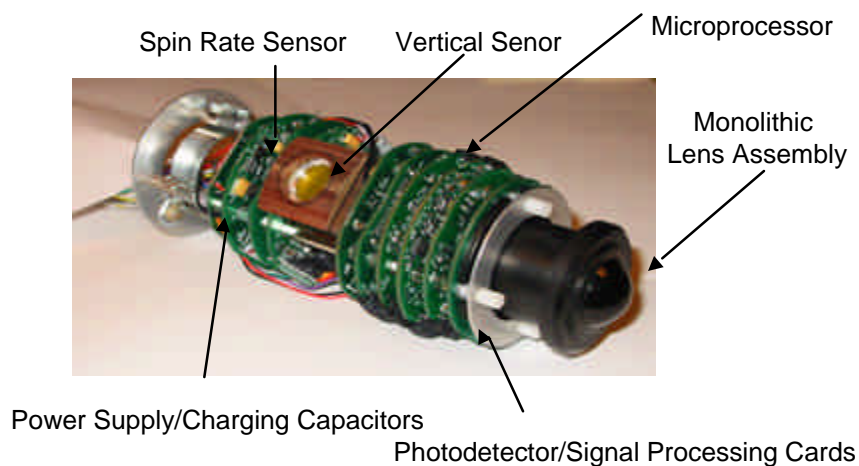
## **Program Objective**

Conduct engineering study to investigate the feasibility of integrating the Low Cost Course Correction Technology as a materiel change program to improve the accuracy of the 120mm mortar.

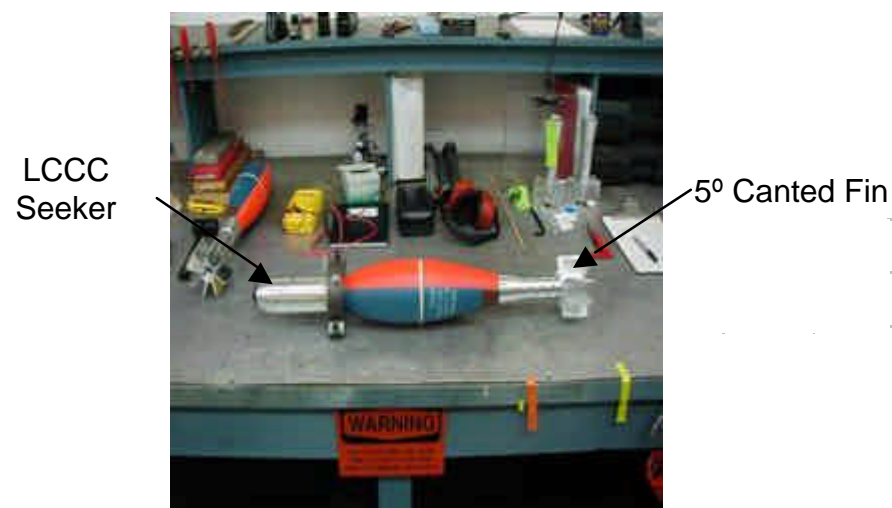
## **Status**

- Completed Phase I feasibility paper study
- Completed Phase II Engineering Study (GD-OTS) – Aug 02
  - Aerobalistic Evaluation at TACOM-ARDEC
  - Diverter Evaluation at Spark Range, ARL
  - Seeker Evaluation at HWIL, Redstone Arsenal
  - Horizontal test firing at OTI, FL
- Option for Lofted Ballistic Test to be awarded Mar 03

# Low Cost Course Correction (LC3) for Mortars



**LCCC Seeker and Electronics**

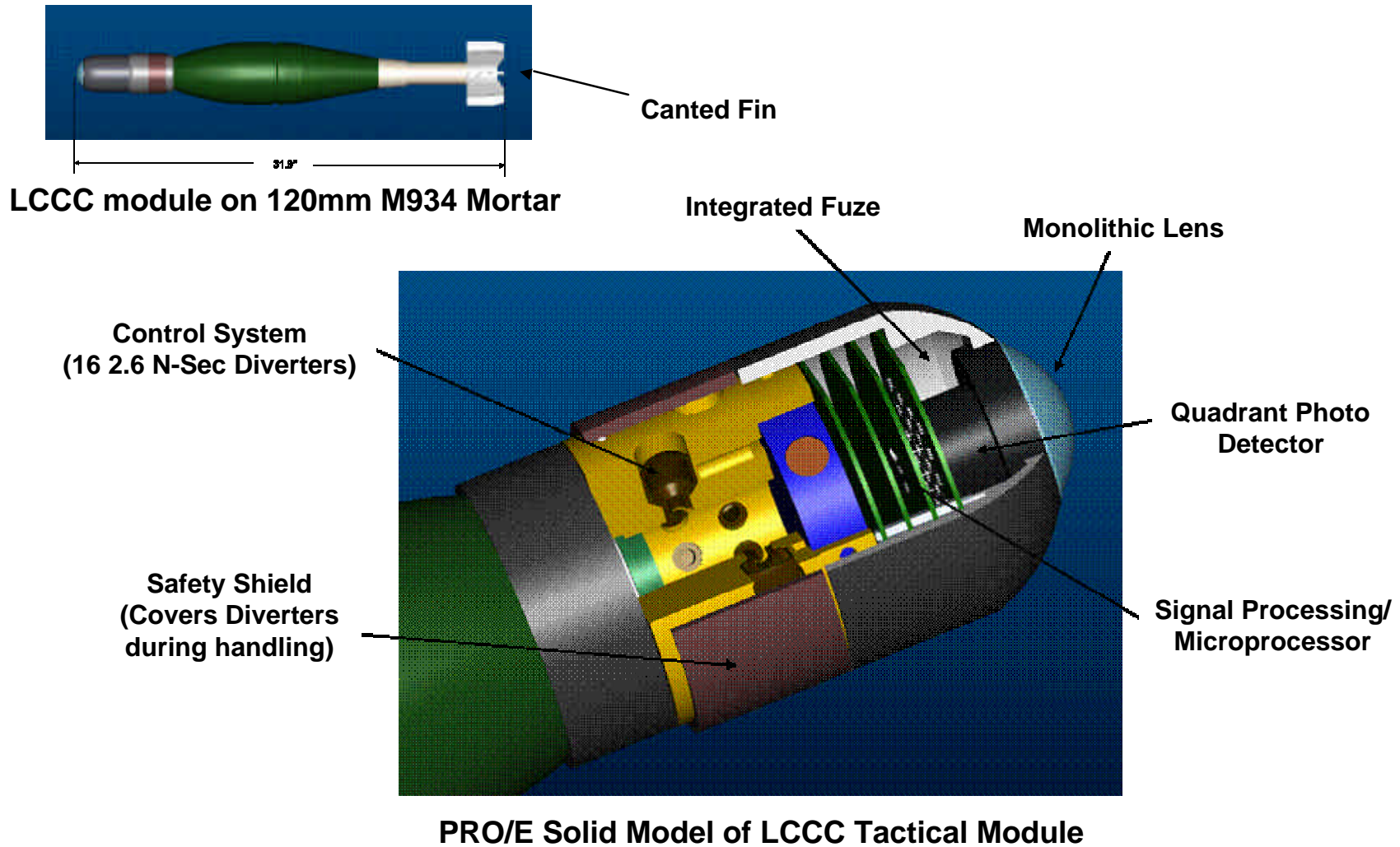


**LCCC Horizontal Test Round**

## **System Characteristics**

- **Concept – Uses microexplosive diverters to correct the projectile trajectory based on optical signals from laser illuminated target**
- **Can yield significant accuracy improvement – less rounds needed to accomplish the same missions**
- **Relatively low cost**

# Low Cost Course Correction (LC3) for Mortars Tactical Design



# ***Low Cost Course Correction (LC3) for Mortars Testing Results***

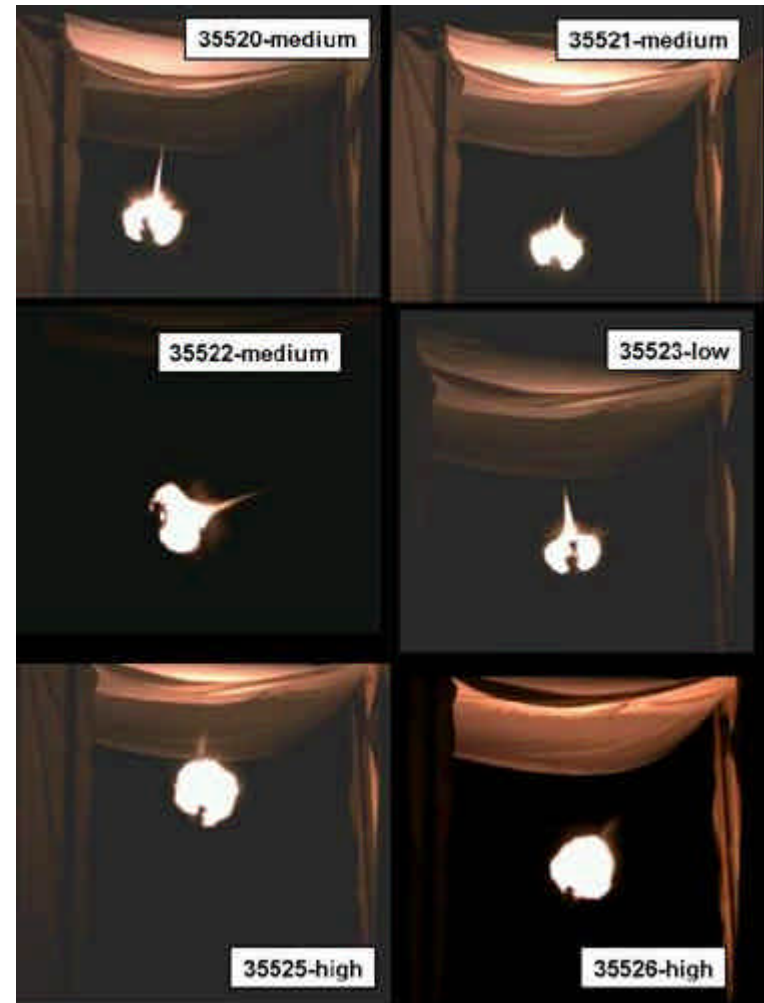
- **Subsonic Wind Tunnel testing at ARDEC:**
  - 2% decrease in stability due to LC3 nose unit, but can be compensated with a drag effect with new canted fin.
- **Diverter characterization testing at the Spark Range, ARL:**
  - The preliminary results show 2 to 6 mils correction achievable.
- **Hardware-in-the-Loop testing at Redstone Arsenal:**
  - Strong agreement between the simulation model and seeker output.
- **Tactical LC3 Horizontal Test firings 6-8 Aug 02 at OTI, Rock Hill, FL. using laser source / target:**
  - All projectiles (6) successfully diverted towards the designated target. Extensive video coverage is currently being processed to determine the exact timing and orientation of diverter events.



# Low Cost Course Correction (LC3) for Mortars Diverter Testing

- The preliminary results show the following:

Round	Total Impulse (n-sec)	Flight Path Correction (mils)
35518	1.0	2.0
35519	1.0	2.0
35520	1.6	3.7
35521	1.6	3.7
35522	1.6	4.2
35523	1.0	2.0
35525	2.6	4.9
35526	2.6	6.0



# Low Cost Course Correction (LC3) for Mortars

## Tactical LC3 Horizontal Testing

Divert event  
expected between  
9:00 and 10:00  
o'clock position



Aim Point



Photo taken just off-center LOS at half way point down range

# ***Low Cost Course Correction (LC3) for Mortars***

## ***Tactical LC3 Horizontal Testing***



# ***Low Cost Course Correction (LC3) for Mortars Phases I & II***

## **Phase I**

- **Defined notional LCCC Module for 60, 81 and 120mm mortar cartridges**
- **Aerodynamic Error Analysis**
- **Effectiveness Analysis**
- **LCCC Draft guidance module requirements**
- **Top level evaluation of impacts of LCCC when integrated with M734A1 fuze**

## **Phase II**

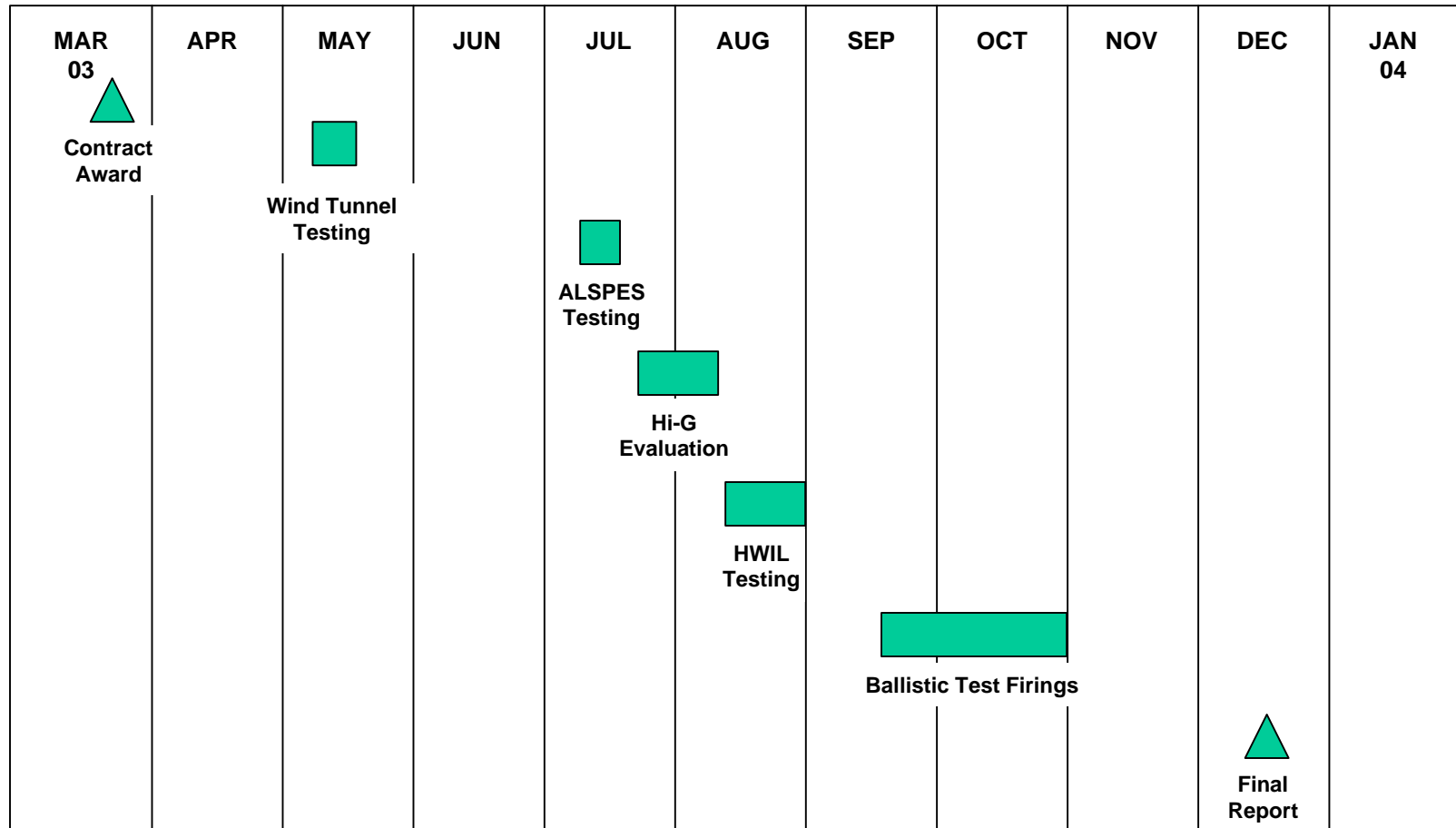
- **Further investigated the benefits of LCCC on the M934 mortar cartridge through a detailed aeroballistic evaluation and horizontal ballistic seeker and diverter experiments**
- **Detailed systems modeling study**
- **Diverter characterization testing**
- **Guidance module testing**
- **Concept fuze integration design and bench testing**
- **Design a canted fin to achieve optimum spin rate for 120mm mortar cartridges**

# ***Low Cost Course Correction (LC3) for Mortars***

## ***Phase III***

- **Aeroballistic Analysis**
  - Continue to develop 6 DOF analysis to fine tune dual-pulse diverter control
- **Effectiveness Analysis**
  - Government generated report to determine the benefit of LCCC as applied to a M934 Cartridge in a relevant environment
- **Tactical Module Design**
  - Revisit ARDEC wind tunnel to qualify nose and canted fin.
  - ALSPEs testing to evaluate the seeker's ability to properly detect laser pulses at the required seeker ranges.
  - HWIL testing to evaluate system performance in a dynamic spinning environment
  - Hi-G environment testing of seeker assemblies at ARDEC air gun
- **Ballistic Flight Test**
  - Fifteen dummy rounds
  - Fifteen complete LCCC rounds
  - Two LCCC rounds without diverters

# Low Cost Course Correction (LC3) for Mortars Phase III Schedule



# ***Low Cost Course Correction (LC3) for Mortars***

## ***Future Application***

- **FCS Extended Range Mortars**

- **2.0.4.1.6** FCS NLOS Mortar must be capable of firing future developmental munitions... (PGMM, DPICM, HE, Smoke, Illum, IR Illum, Training & Non-lethal), 12 km (Threshold), 15 km (Objective)
- LCCC could be applied to all future FCS rounds
- ARDEC currently studying effects of LCCC on Extended Range Mortars

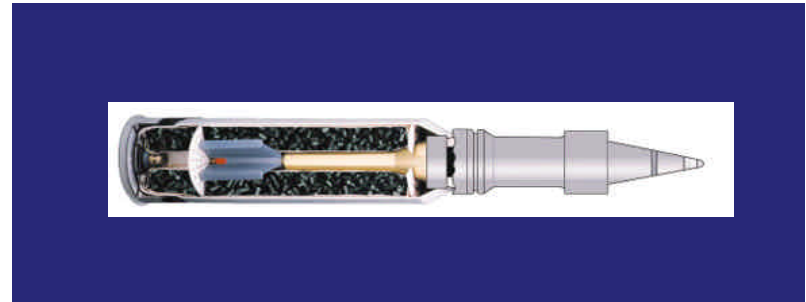
- **Congressional Language**

" M934 Mortar - Low Cost Course Correction Module - The conferees are aware of recently concluded tests sponsored by Army PM-Mortar which support further demonstration and evaluation of the Low Cost Course Correction (LCCC) module for the M934 Mortar. The conferees also note the positive performance of the LCCC module as reported by the Army and encourage the Secretary of the Army to address future funding requirements for the LCCC module and future testing requirements."

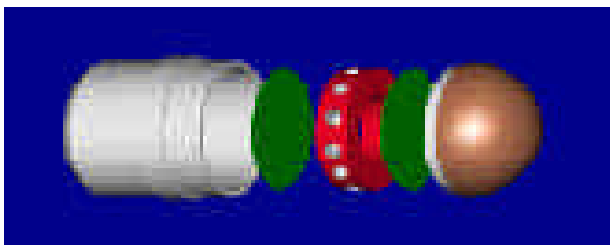
## *Other LCCC Applications*



**2.75" Rocket**



**M830A1**



**40mm Grenade**



**105mm HE M1 (AC130)**