ENHANCED EXPEDITIONARY

ENGAGEMENT CAPABILITY

Advanced Capability Extended Range Mortar (ACERM)

2016 NDIA Armament Systems Forum

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Overview

- Last time we were here … (Baltimore)
  - Presented new 81mm Concept Projectile for USMC Infantry Organic Fires
    - Advanced Capability Extended Range Mortar (ACERM)
    - Maximum Range: 10km (T) – 20km (O)
    - GPS+SAL Guidance: 10m CEP_{50} (T), 1m CEP_{50} (O)
  - Developed but not Flight Tested
    - Wind Tunnel, Shock Environment, & Hardware-in-the-Loop Only

- As of Today …
  - Completed 2x Live Fire Flight Tests
  - Survivability & GPS Guided Flight Demonstrated
    - 19.1km Maximum Range
      - 81mm Mortar World Record (unofficial)
    - 13.7km GPS Guide-to-Hit with < 10m CEP_{50}

Radical Capability increase for Organic Infantry Fire Support

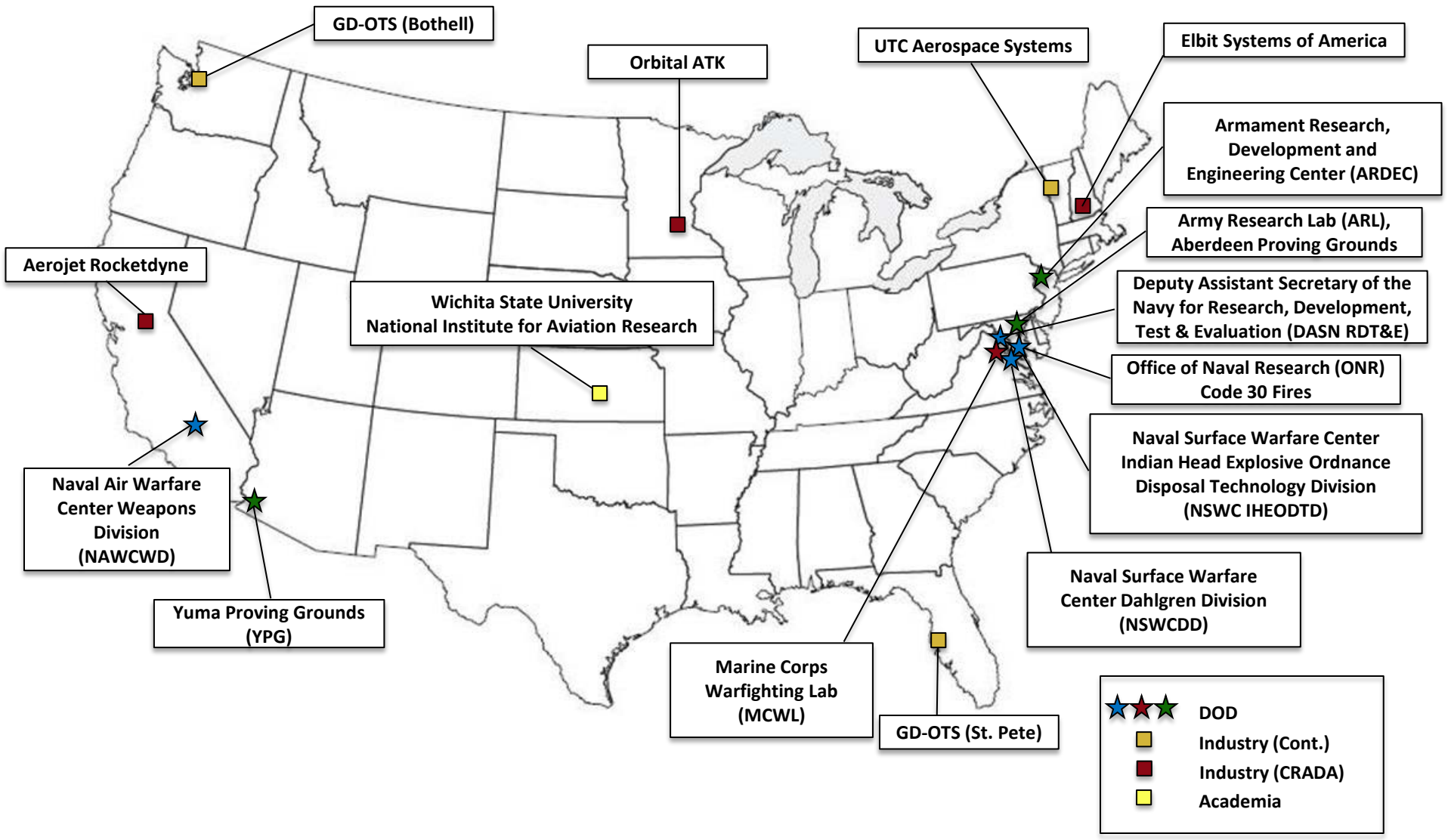
Catalyst/Enabler for New Warfighting Concepts

E3C Program

- Sponsor:
  - ONR 30 Fires
- Objective:
  - Demonstrate the "Art of the Possible" in fire support technologies for USMC weapons, through an ongoing series of integrated system firing demonstrations
- Structure:
  - Demonstrate systems to TRL 5-6
  - Transition Systems and/or Technologies to Acquisition or FNC programs
  - One new caliber every 3-4 years
  - Flexible to meet future stakeholder needs

First up is 81mm Mortar
Followed by *155mm Artillery* & 60mm Mortar

E3C Development Team



E3C 81mm System

Advanced Capability Extended Range Mortar (ACERM)

- ***New 81mm Precision AUR***
- ***Dual Mode GPS + SAL Guidance***
- ***>20km Maximum Range***

Precision for Future Infantry Units for both Mounted and Dismounted Operations

Miniature Mission Setter (MMS)

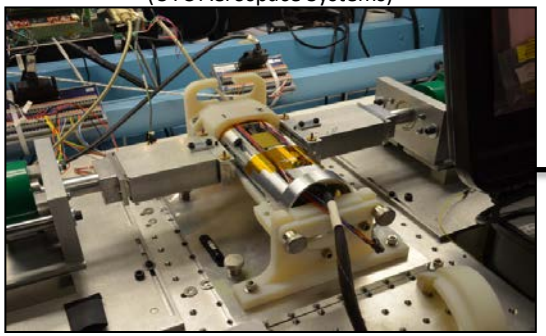
- ***<4lb Precision Weapon & Fuze Setter***
- ***Logistic Enabler for Foot Mobile Precision***

Low Cost SAL Seeker (LCSS)

- ***Enables 1m CEP50***
- ***Eliminates TLE***
- ***GPS Denied Precision Fires***

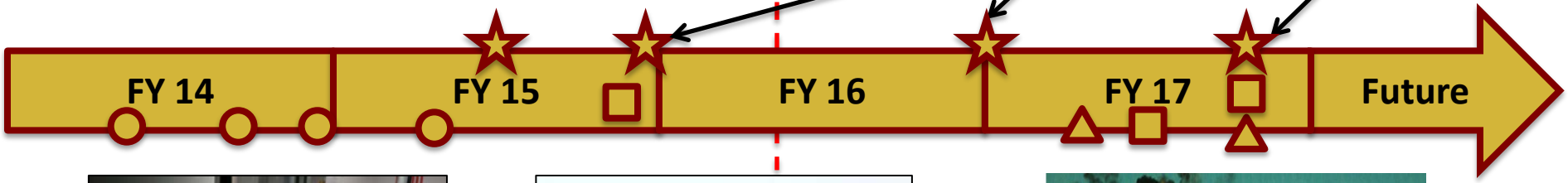
Demonstration Schedule

Hardware-in-the-Loop Testing
(UTC Aerospace Systems)



Live Fire Testing
(Yuma Proving Grounds)

JTAC-LTD & Skylark I-LE UAS
(Elbit Systems of America)



Wind Tunnel Testing
(NIAR, Wichita State University)

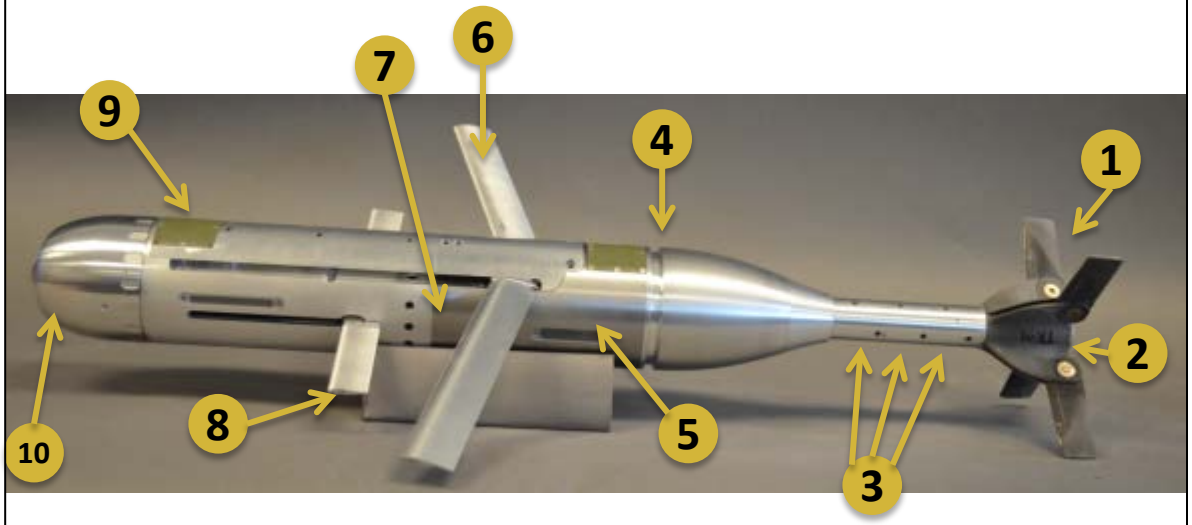
Miniature Mission Setter (MMS) Integration
(GD-OTS)

Live Warhead Testing
(Aerojet Rocketdyne)

TRL 6 Demonstrations in FY17 @MCWL Coordinated Warfighting Experiment

ACERM Cartridge

- New 81mm AUR
  - Airframe co-developed by NSWCDD, ARL, & UTC Aerospace
- Ultra Extended Range
  - 10 km (T), 20 km (O)
  - Aerodynamics only, No rocket motor
- Precision Delivery
  - GPS – 10m CEP_{50} (T), 5m CEP_{50} (O)
  - SAL – 5m CEP_{50} (T), 1m CEP_{50} (O)
- Cost Effective
  - $15k/unit (T), $10k/unit (O)
  - Comparable to existing systems



1. Super Caliber Deployable Tail-Fins
2. M299 Ignition Cartridge
3. ERMA Propelling Charges (not shown)
4. Split Ring Obturator (not shown)
5. Enhanced Lethality Warhead
6. Lifting Wing
7. MEMS S&A Fuze (inside shell)
8. Dual Independent Steering Canards
9. Global Positioning System (GPS)
10. Low-Cost SAL Seeker (LCSS)

Extended Range Minimizes Re-Emplacements, Keeps Pace with Mobile/Dynamic Engagements

Making Range

1

Launch
- Mass
- Velocity
- Launch angle
- Drag
- Apogee Alt

2

R_G Gliding Flight Range Extension
- Wing area
- Lift
- Drag

3

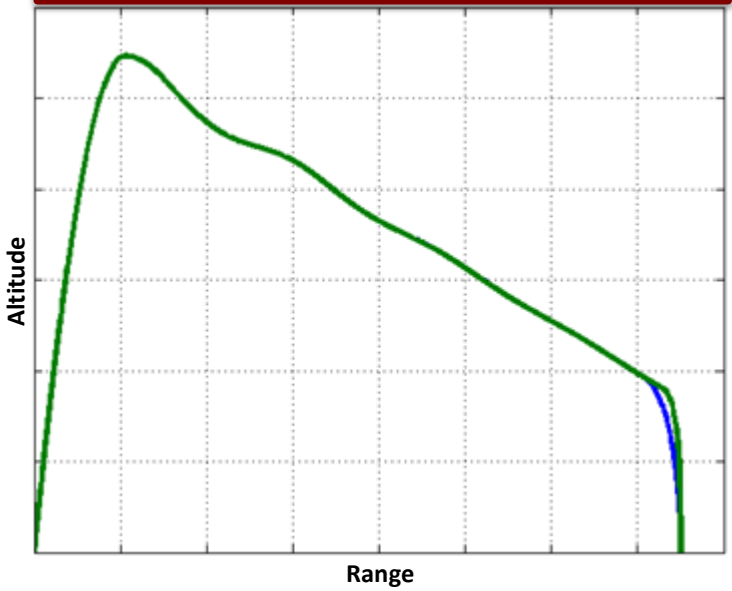
R_R Range Reduction
- Target Acquisition
- Terminal Maneuvers

20-22 km Maximum Range
Based on Latest Flight Test

Glide Architecture Provides >60% of Range Without Need for In-Flight Propulsion

Lift + Control = Maneuverability

Enables 81mm Fire Support to participate in Urban/Defilade Engagements at Range



Low-Cost SAL Seeker (LCSS)

Now → **FY 16** → **FY 18**

Coming Soon

LCSS v2

- STANAG 3733 SAL Targeting Sensor
- 0.5 lb, 6.3 in^3
- Capable down to 10 mJ/pulse
- External Projectile Sub-System
- Hardened to 10 kgee's
- Est. $1k unit @ 10k rate
- 35 prototypes delivered

LCSS v3

- LCSS V2 Capabilities +
- 0.3 lb, 4.0 in^3
- Internal Projectile Sub-System
  - Optics must be ported
- Embedded Ranging Sensor for Precision HOB
  - 1-20m Selectable w/ 3.5% err.
- 2 prototypes ordered

LCSS v4

- LCSS V3 Capabilities +
- 0.3 lb, 4.0 in^3
- Guidance Processor
- Inertial Sensor Suite
- Additional I/O for CAS, Fuze, and Other Guided Projectile Subsystems

Future Development Will Yield LCSS v2 Capabilities in *80% Smaller* Form Factor

FY17 DOTC Topic

Miniature Mission Setter (MMS)

- Man Portable System
  - Enables smaller PGMs and Foot Mobile Precision
  - Weight < 4lbs
  - Leverages 8” Tablet Computer from Target Handoff System (THS)
- Improved Power Efficiency
  - Direct Contact Interface
  - Environmentally Rugged Connector Developed
- Android Open Architecture Touchscreen Interface
  - Intuitive and familiar
  - Minimal User Input Required
  - Expansion to Host Additional apps (Mapping, Force tracking, Mission Planning, Intel)
- EPIAFS Backwards Compatibility
  - Already generates same data message format
  - Inductive setter output through Legacy Compatibly Kit

Partnering with MARCORSYSCOM to Mature MMS as logistic enhancement for Expeditionary Fire Control System (EFCS)

PLUMSS: 40 lbm, 3120 in^3

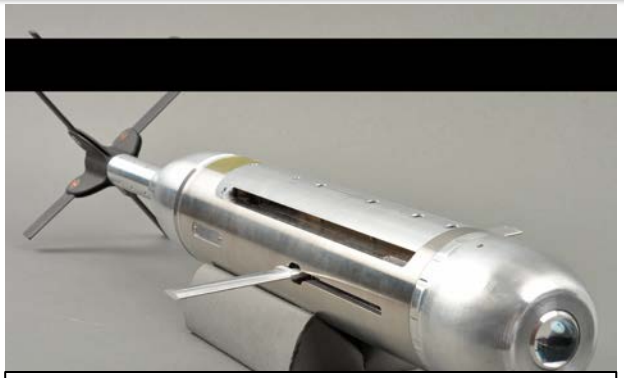
MMS**:** <4 lbm, 100 in^3

Current MMS Features:
- Android Tablet (8” Screen)
- Embedded SAASM GPS
- Crypto Storage/Handling
- Rugged Weapon Connector
- High Power Battery
- Two-Wire/Tac-Link Modem

Flight Test #1 (FT1)

- ACERM Survivability & Roll Control (6 Rounds)
  - Survivability of Key Sub-Systems
  - Validation of Wind Tunnel Aerodynamic Data
  - Active Roll Control Demonstrated
  - Validated IMU Capabilities
  - LCSS Track on Designated Target (Ride-Along)
    - Using GLTD II
  - Precision Delivery – 3,200m Target
    - 10-20m Miss Distances using C/A GPS
- ERMA Propellant (10 Rounds)
  - ACERM Ballistic Slugs
  - Charge weight assessment & validation
  - Achieved 292.5m/s on 13.5lbm fly away mass

Groundwork Laid for Extended Range 81mm Flight Testing

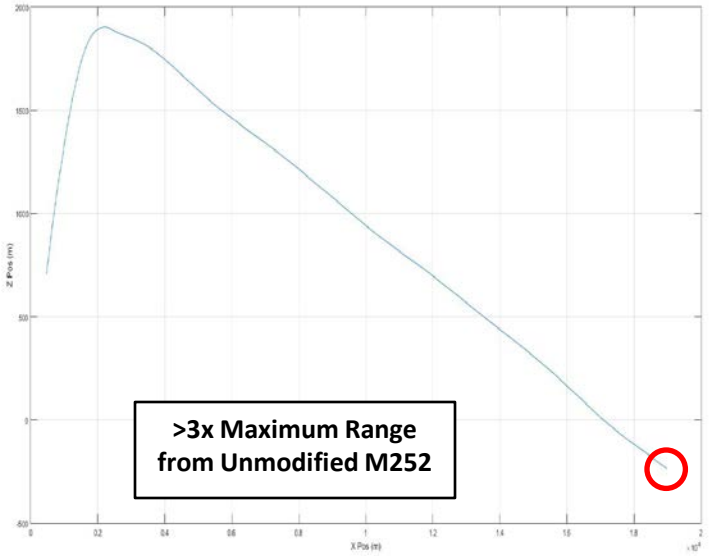


ACERM FT1 Test Projectile
- No Wing
- Diagnostic Telemetry Module (DTM) Warhead Surrogate
- No Tactical GPS, C/A Code GPS in DTM
- M38 Propellant (Zone 3)

Flight Test #3 (FT3)

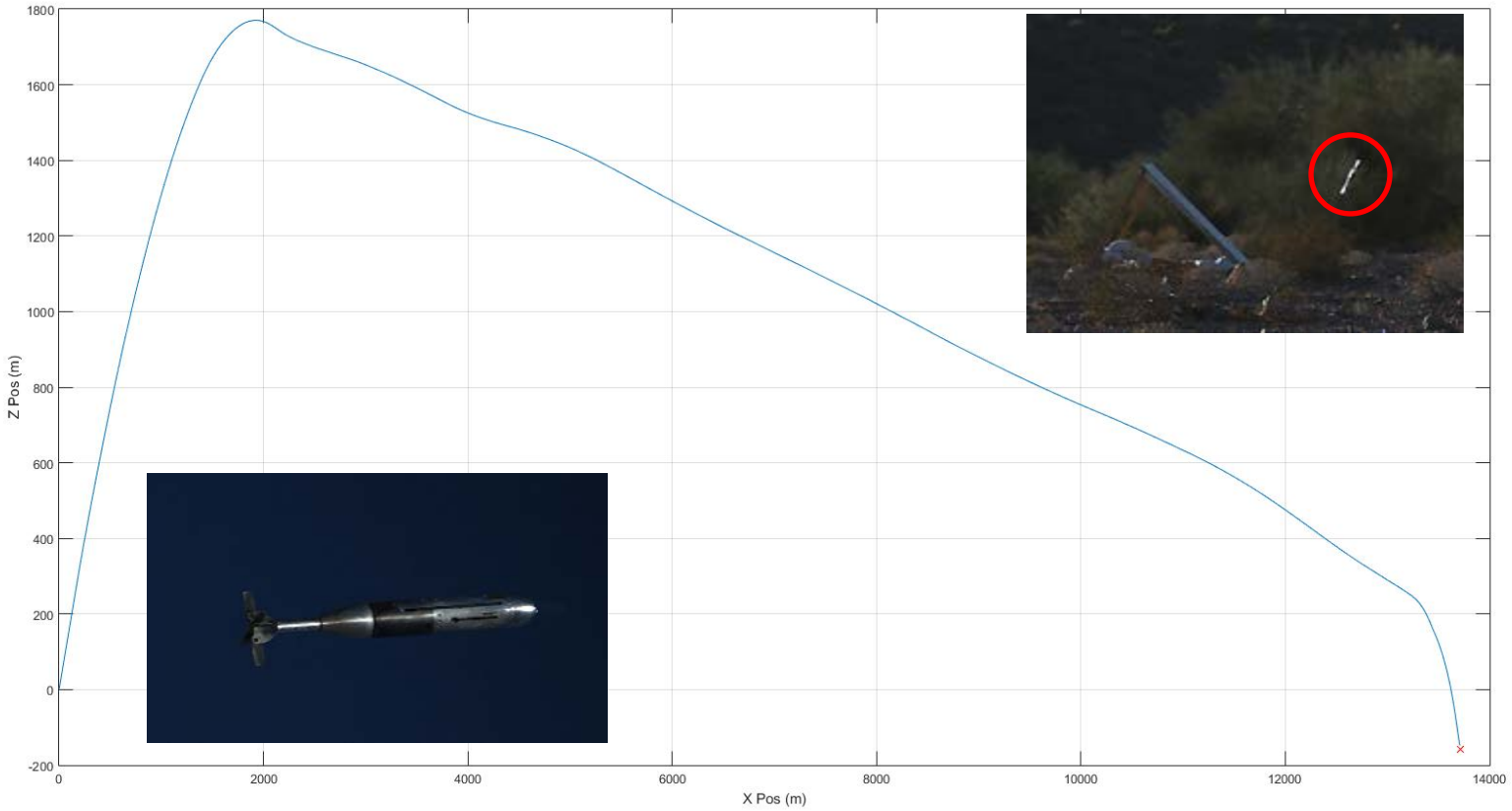
- ACERM Extended Range and Closed Loop Precision Guidance (8 Rounds)
  - Full ACERM Configuration
    - Diagnostic Telemetry Module (DTM) Warhead Surrogate
    - C/A GPS in DTM, C/A GPS (L3) in GNC
  - Validation of Full Airframe Design
    - Outperformed Predictions,
  - Combined Test Objectives with unfunded FT2
    - Open Loop Guided Flight

- Results
  - 19.1km Maximum Range Glide
    - GPS Navigation to Hold Line-of-Fire, ERMA Propellant (290m/s)
    - Unofficial Record for 81mm Maximum Range
    - 22km Maximum Range possible w/o any changes
  - GPS Guide-to-Hit at 13.7km
    - 1.7m and 5.3m miss distances
    - ERMA Propellant – Reduced Charge (243 m/s)
  - LCSS track on Designated Target (Ride-Along)
    - Using AN/PEQ15 JTAC-LTD



FT4 Test Scheduled for Oct/Nov '16
SAL Guidance Against Static & Moving Targets

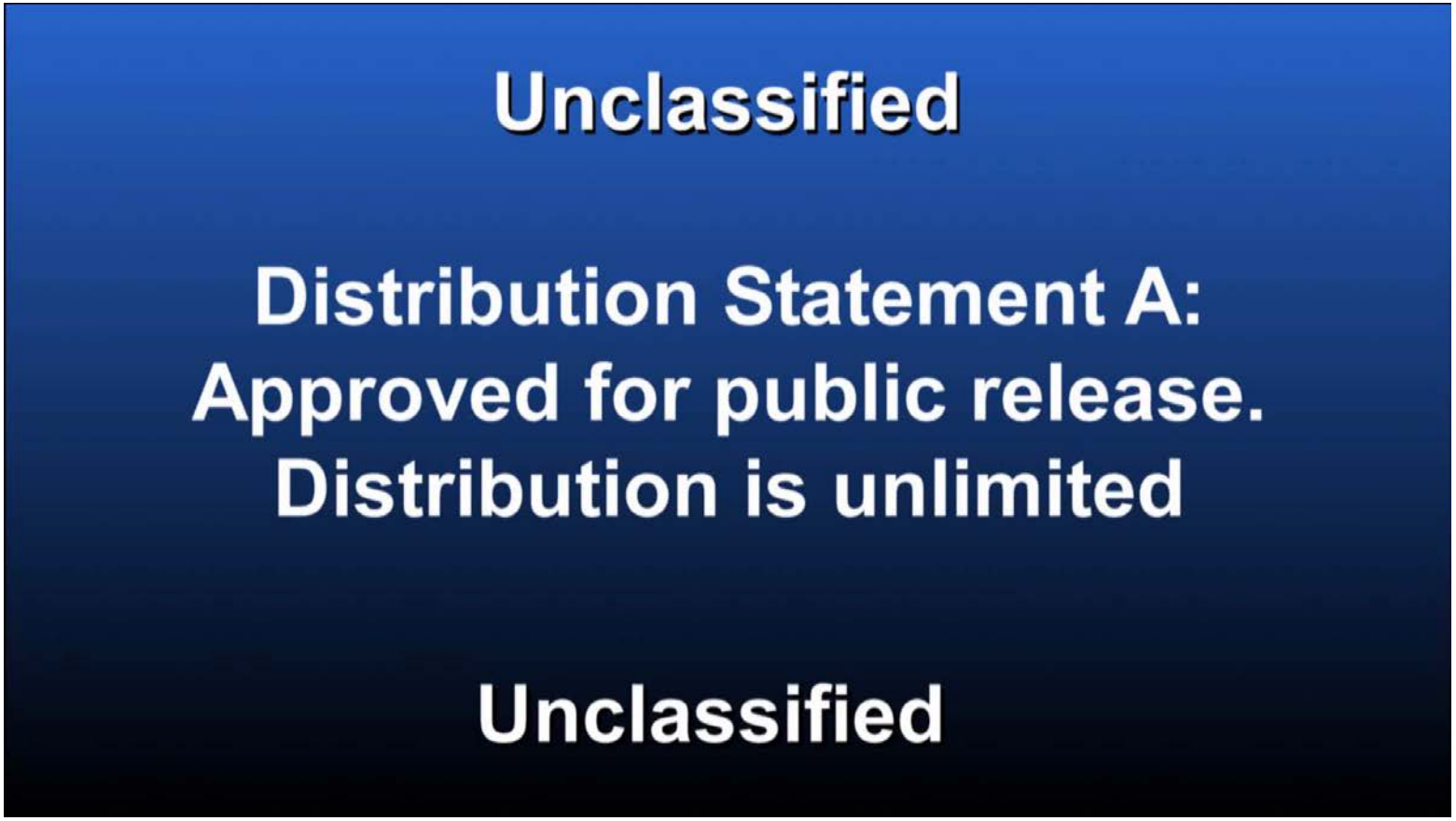
Range vs. Altitude



1.7m Miss @ 13.7km target – Reduced Launching Charge (243m/s)

(Target altitude below gun position)

FT3 GPS Guide-to-Hit Video



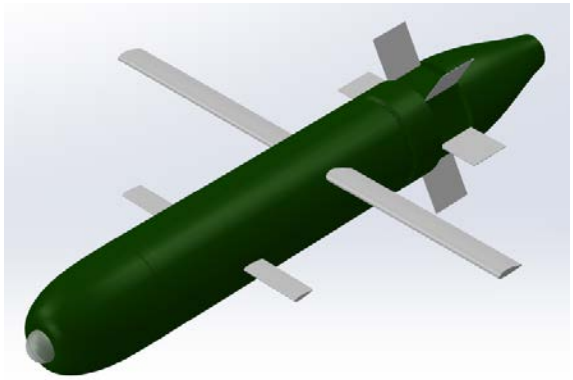
Advanced

- 120mm ACERM
  - 24km (M120) to 33km (M327) Maximum Range
  - GPS+SAL Precision Guidance
  - Already designed and under test through IR&D effort

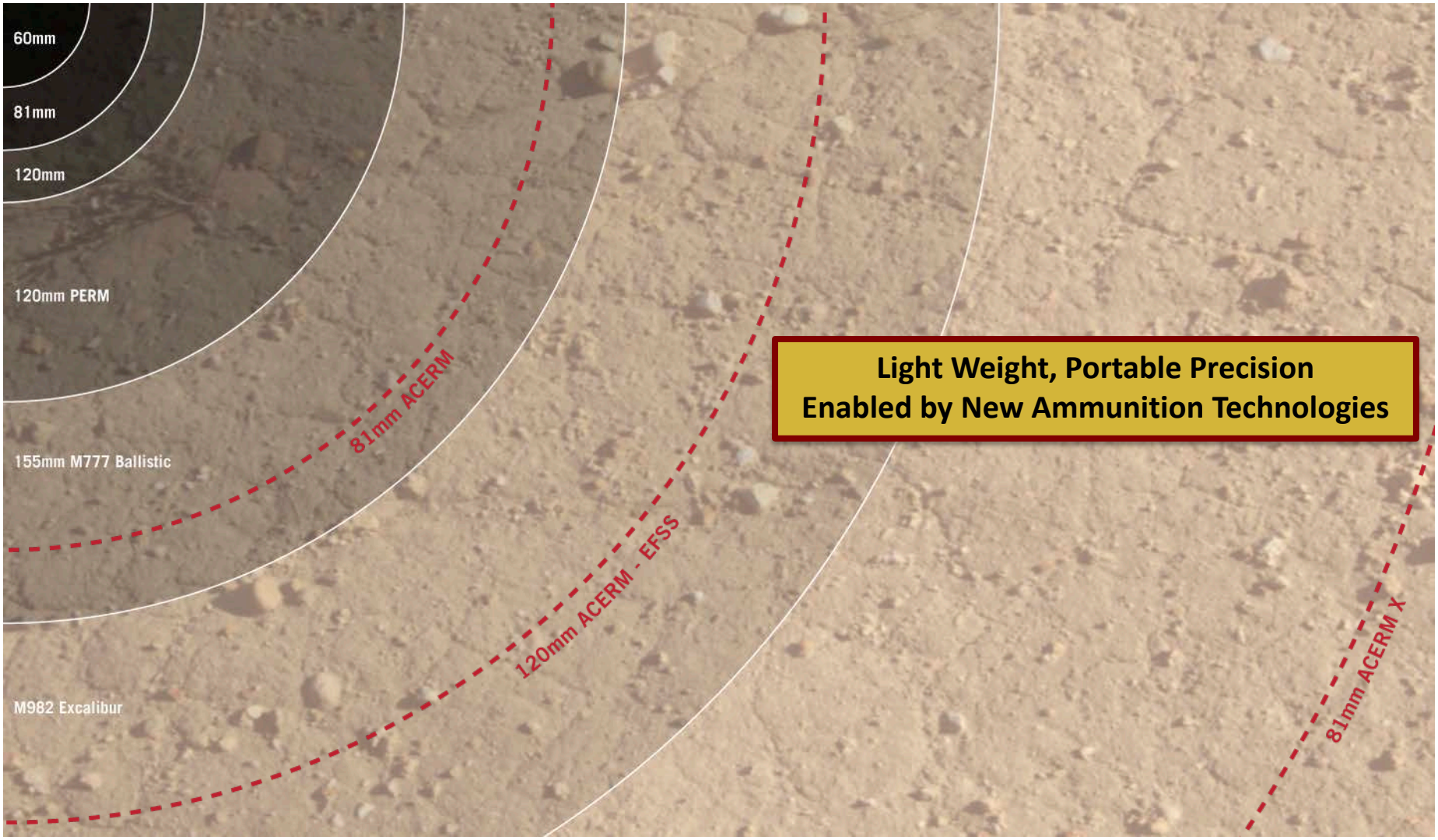
- Air Dropped (ACERM Air)
  - Small form factor “SDB-Style” capability for UAS
  - Minimal Changes to Fuzing required
  - Engage targets within radius = 6x Altitude

- eXtreme Performance Configuration (ACERM-X)
  - 40 – 60 km Maximum Range
  - TOF to 15 km reduced to <120 sec

- Naval ACERM
  - Readily adaptable to Navy 5-Inch and other gun systems
  - 81mm mortar can be installed directly on small/intermediate class ships
  - Low-Cost fire Support capability for Littoral/Riverine operations



Current Fires vs. ACERM



Conclusions

- ACERM can expand Infantry Fire Support Envelope with Organic Assets
  - 81mm Precision Fires to >20 km
  - Can keep pace with dynamic/mobile engagements
  - Cost Comparable to Existing Precision Fire Support

SAL Guidance & Moving Targets Demonstration in Oct/Nov

- As Part of E3C System
  - Urban Terrain Engagements
  - Continued Operations During GPS Denial
  - Foot Mobile Precision

TRL 6 Capability Demonstrations in FY 17

- Future ACERM Capabilities
  - 120mm Variant
  - Air-Dropped Variant for UAS with SDB Style Capabilities
  - Ultra Extended Range (>40 km)
  - Naval Fire Support

- Questions?