



**US ARMY ARMAMENTS RESEARCH, ENGINEERING AND
DEVELOPMENT CENTER**



120mm Mid Range Munition (MRM)

ARDEC S&T Effort



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Providing America Advanced Armaments for Peace and War



Outline



- **Program Overview**
 - Background/History
- **MRM Technology Development**
 - Airframe
 - Lethality
 - GNC/Seeker
- **MRM Integrated TRL6 Demonstrations**
 - Autonomous
 - Semi-Active Laser (SAL)
 - Dual Mode
- **Summary**



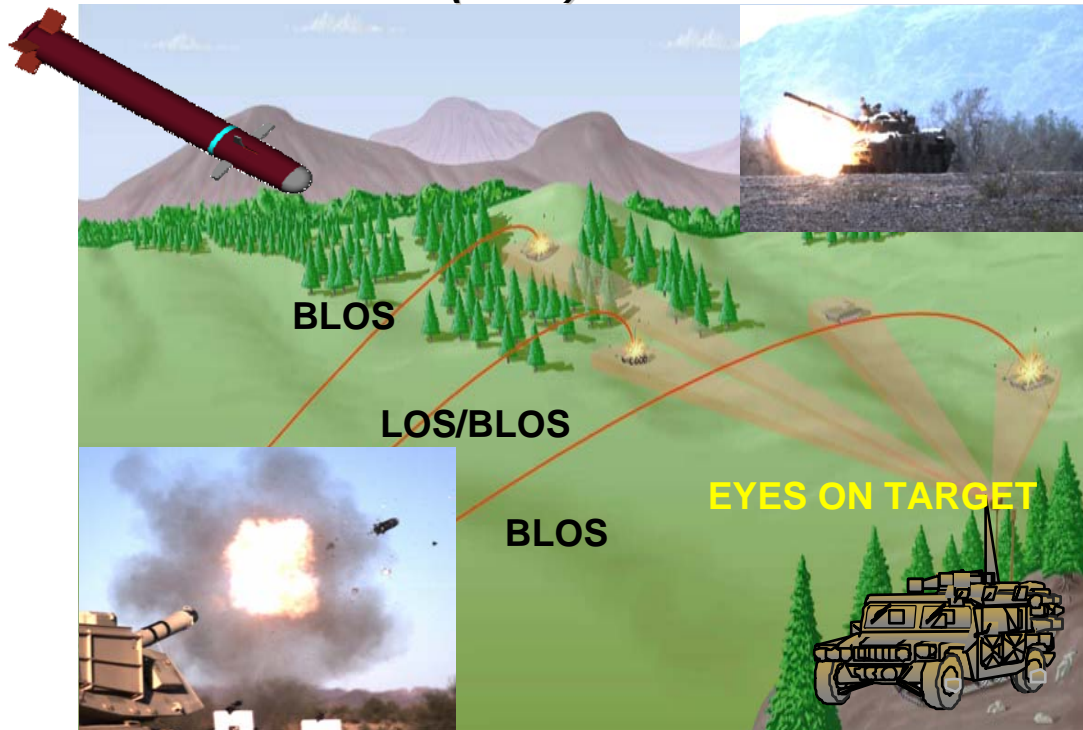
What is MRM???

FCS MCS Mid-Range-Munition (MRM)



Objective: Provide the FCS Mounted Combat System (MCS) with a precision munition capable of defeating LOS/BLOS threats out to 12km.

Goal: Develop and integrate the necessary technologies to demonstrate a TRL 6 precision munition, ready for Milestone B and System Development & Demonstration (SDD) Phase.



SYSTEM CHARACTERISTICS:

- Precision Munition for FCS MCS Vehicle
- Designed to Defeat High Pay-Off
- Fleeting Targets (MBTs with ERA, APCs, Artillery, etc.)
- Incorporates Autonomous and Designated Seeker Modes
- Operates in Line-of-Sight or Beyond Line-of-Sight from 2km to 12Km

Extended the Capability to Defeat Heavy Armor out to 12Km



BLOS Operational Modes



MRM provides an extended range (BLOS) precision kill capability to the FCS Mounted Combat System enhancing the lethality and survivability of the system.

- Autonomous
 - Mmunition Searches & Engages Target
- Designate
 - Mmunition Searches for Laser Spot on Target and Engages
 - Terminal Phase – Mmunition Conducts Aim Point Refinement to Maximize Lethality
 - Reverts to Autonomous Mode if Spot is Lost or not Found
- Designate Only
 - Same as Designate Except if Laser Spot is Lost or not Found – Mmunition Does not Revert to Autonomous Mode
 - Enables Added Control Under Highly Restrictive ROE

Robust Design Maximizes Operational Flexibility and Lethality



MRM - System Video BLOS Engagement





Mid-Range Munition Concepts



MRM-KE



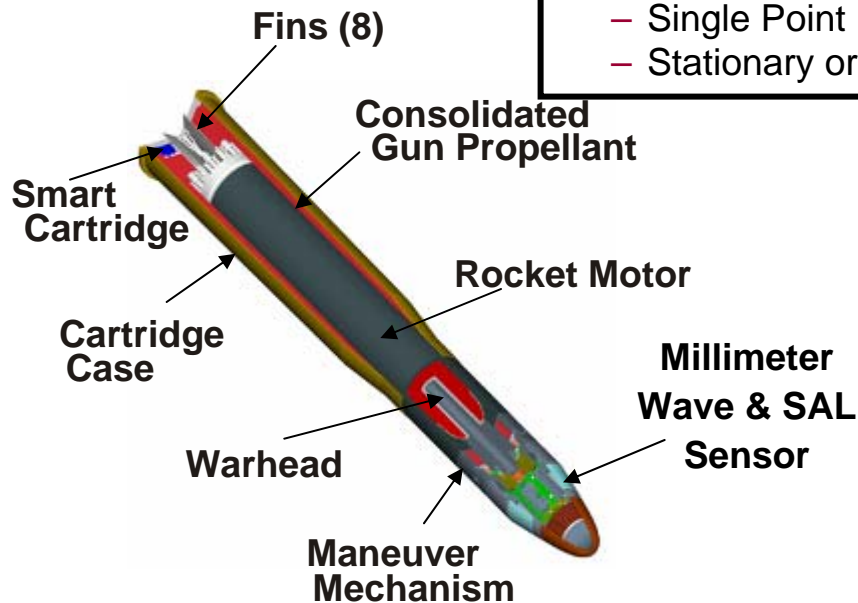
•Target Types

- Main Battle Tanks (MBT) w/ ERA
- Light Armor (BMP)
- Self Propelled Artillery (SPH)/(MRL)
- Air Defense Artillery (ZSU)
- Bunkers (Earth & Timber)

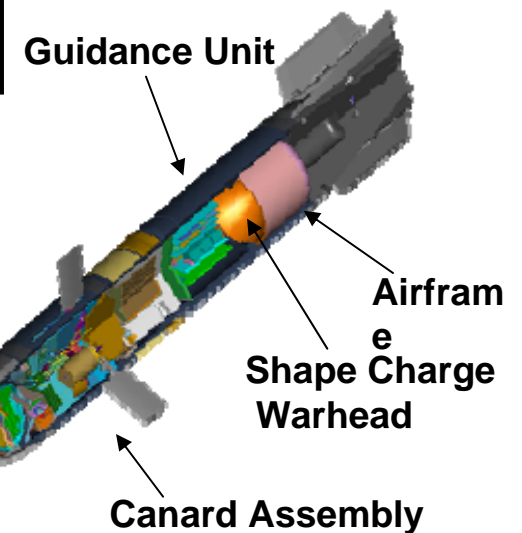
•Attributes

- Fleeting High Payoff Targets
- Single Point Defeat
- Stationary or Moving (Fleeting)

MRM-CE



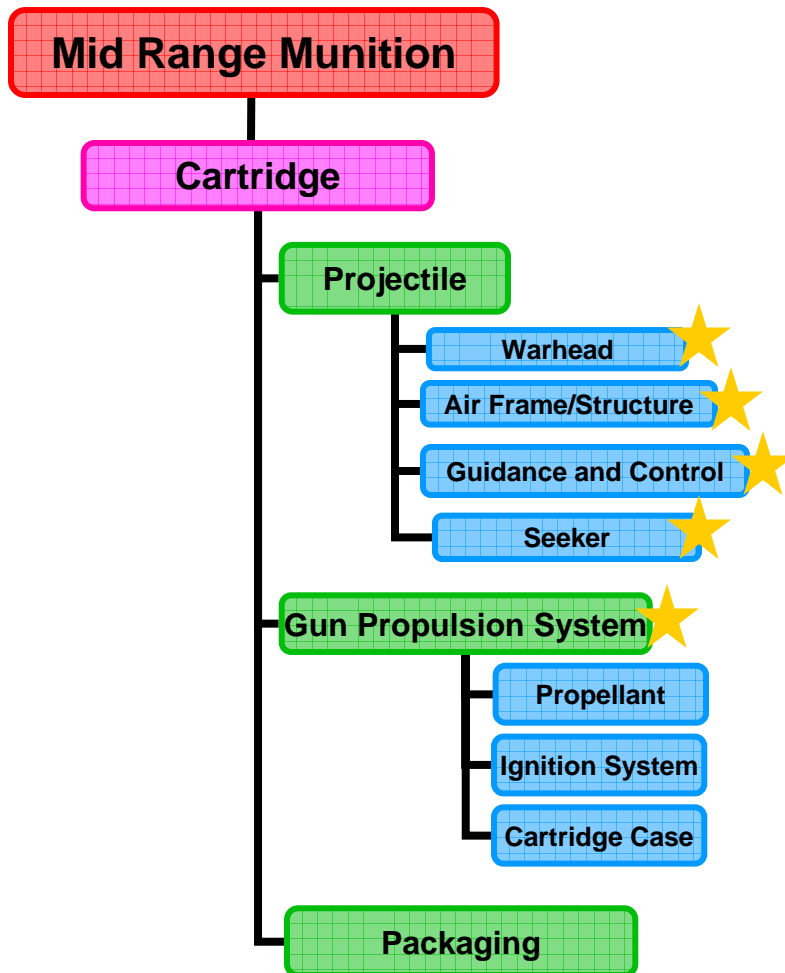
Dual Mode Seeker
Uncooled IIR
& SAL



Program has Achieved Autonomous, SAL, and Dual Mode TRL 6!



MRM Program Approach



- Bring all Critical Technologies to TRL 6
- Develop two concepts in parallel to reduce program risk
- Team with PEO-AMMO (PM-MAS) to facilitate/accelerate transition to SDD

 Recommended Critical Technologies



MRM

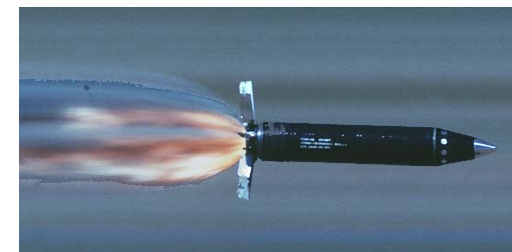
Warhead Subsystem



- **Technology:**
 - MRM- KE: Kinetic Energy warhead with rocket motor boost to kill velocity
 - MRM-CE: Shaped Charge warhead penetrates the target's main armor to provide high overall lethality.
- **Achieved: TRL 6**
- **Basis for Assessment:**
 - Verified LOS and BLOS lethality by HARP gun and static fire tests against the threat range targets (including ERA)
 - Demonstrated Lethality on Heavy Armor and Non Heavy target (Bunker)
 - Defeats ERA and APS with high delta velocity prior to impact
 - Pk Analysis from ARL indicates excellent System Performance



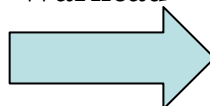
Kinetic Energy warhead



Smear from Round #109



Shaped Charge Warhead





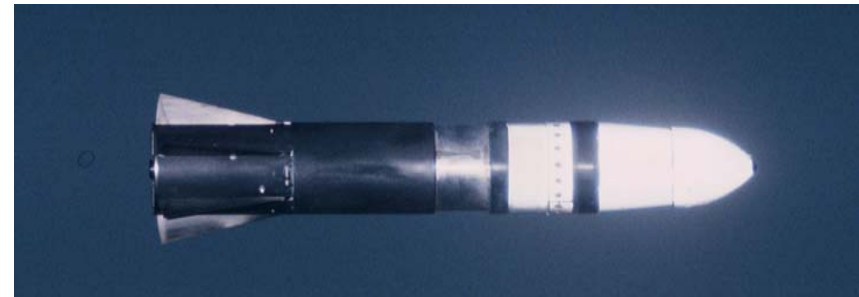
Air Frame Subsystem



- **Technology:**
 - Robust and maneuverable airframe for BLOS range
 - Deployable Fins
- **Achieved: TRL 6**
- **Basis for Assessment:**
 - Conducted Wind tunnel testing and 6-DOF Aero. Model
 - Demonstrated Airframe structure integrity and BLOS flight at tactical velocities
 - Verified max. range capability
 - Demonstrated rocket motor boost to kill velocity
 - Demonstrated performance across temp. range
 - Validated in GTH testing



MRM-KE



MRM-CE

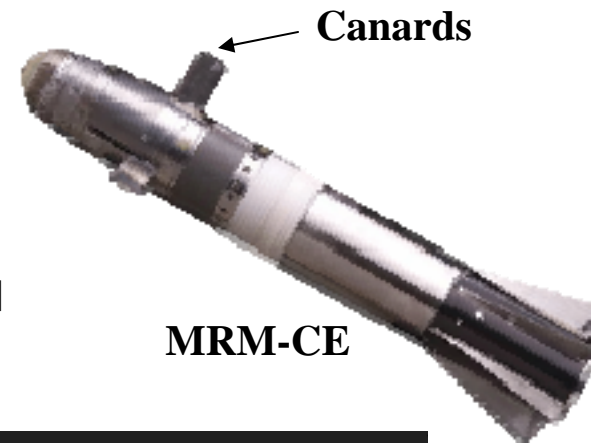


MRM

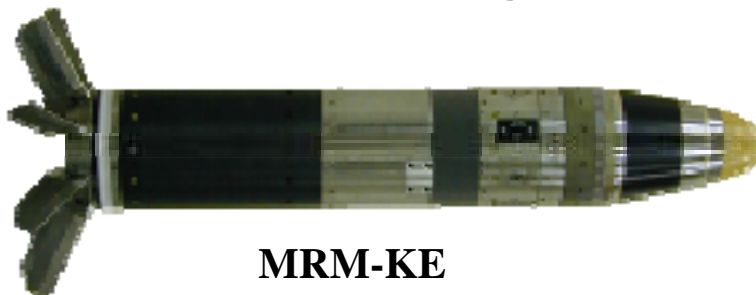


Guidance and Control

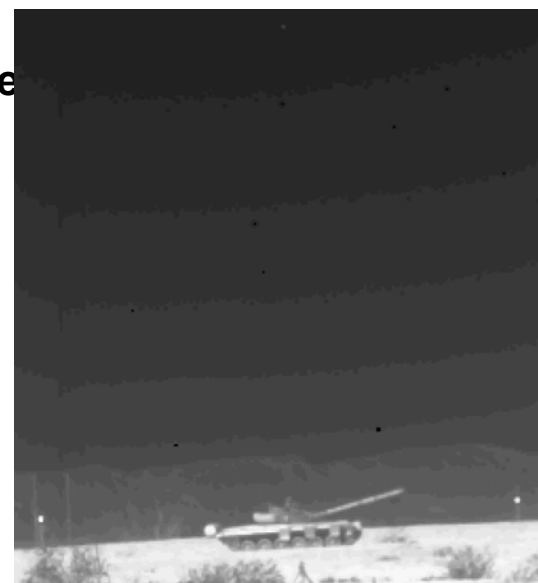
- **Technology:**
 - Thrusters, Canards, IMU
- **Achieved: TRL 6**
- **Basis for Assessment:**
 - Verification of designs was completed through Finite element modeling, rail gun testing, bench testing and ballistic testing.
 - Demonstrated pre programmed maneuver projectiles fired from 120mm gun – all survived setback
 - All projectiles performed requisite maneuver commands
 - Tactical maneuver authority was demonstrated
 - Software verified through IFS, PIL and HIL
 - Validated in GTH testing



MRM-CE



MRM-KE



MRM-KE

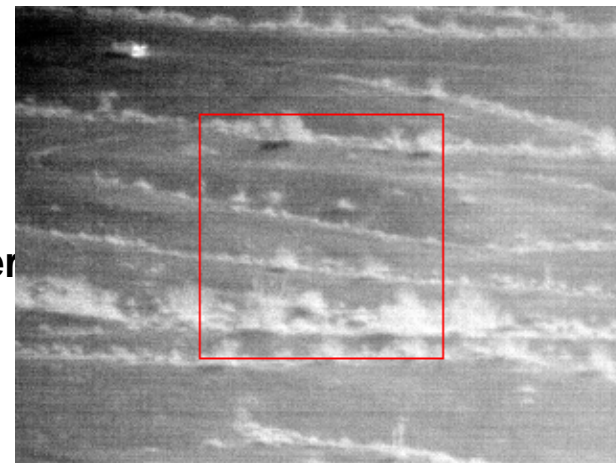


MRM

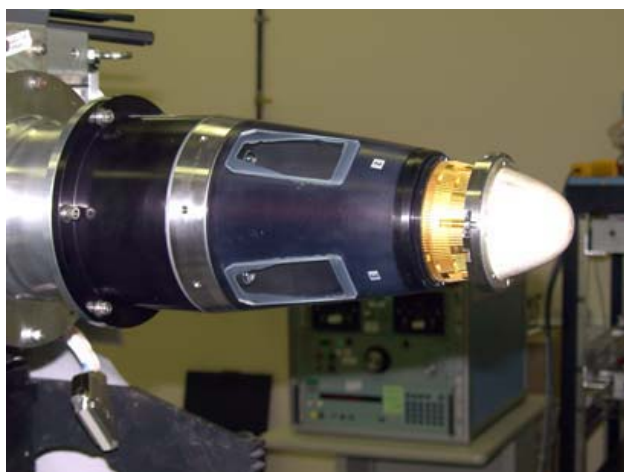
Seeker Subsystem



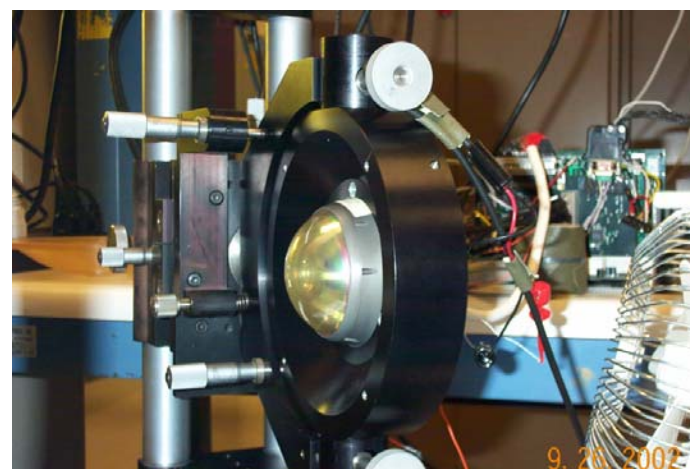
- **Technology:**
 - Un-cooled IIR and SAL sensor
 - MMW and SAL sensor
- **Achieved: TRL 6**
- **Basis for Assessment:**
 - Performed extensive rail and gun testing of the Seeker Assembly to ensure Hi G survivability.
 - Extensive CFT testing/demonstrated Pacq and tracking capability
 - Software verified through IFS, PIL and HIL
 - GTH demo's validated integrated system



MRM CFT



MMW & SAL



IIR & SAL



MRM Accomplishments



- ✓ **Autonomous GTH Demo - 2004**
Stationary target at 5.2 Km



- ✓ **SAL GTH Demo - 2006**
Moving target at 8.7 Km



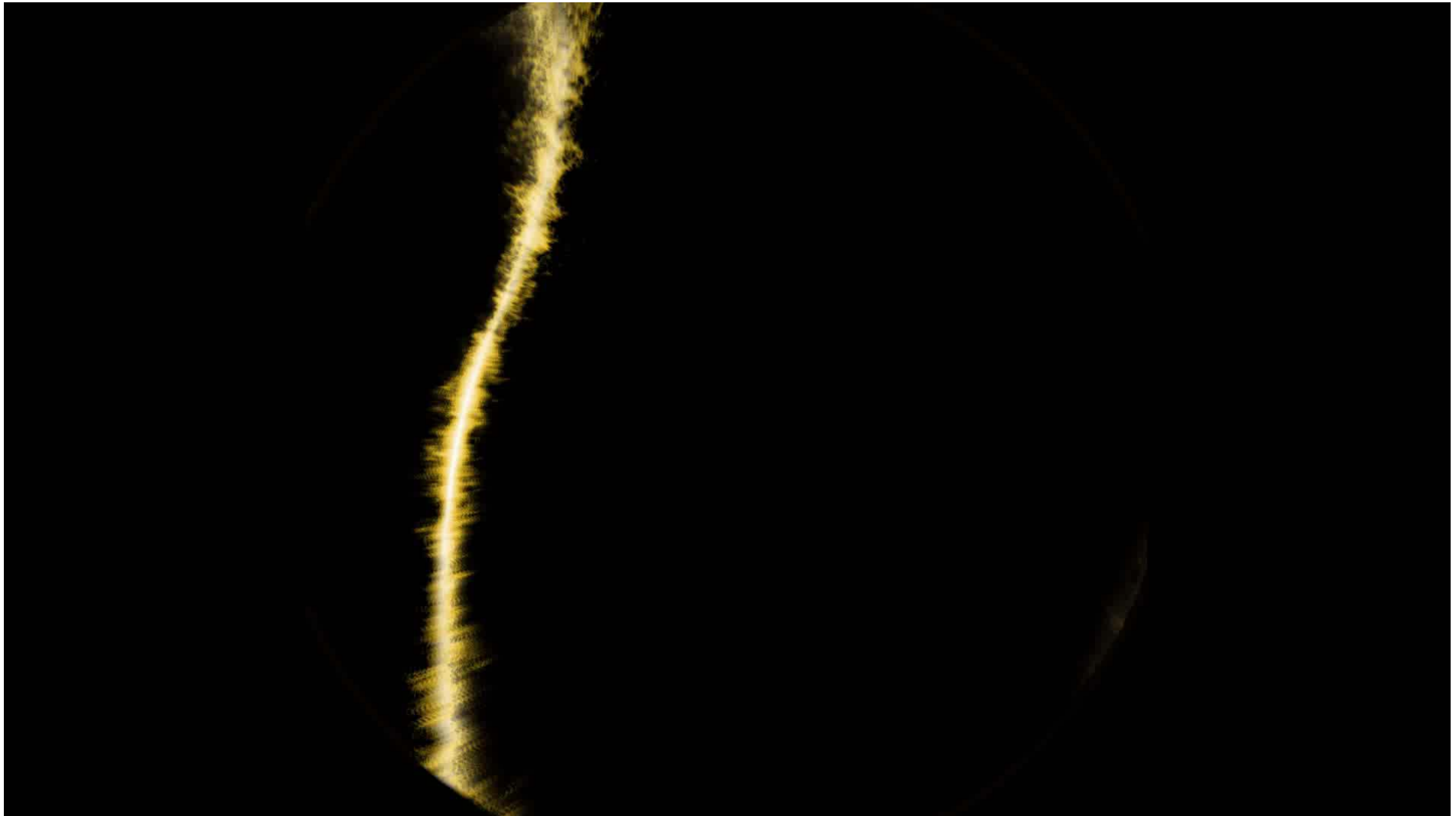
- ✓ **DMS GTH Demo - 2007**
Stationary target at 5.2 Km
Off set designation



Program has achieved Autonomous, SAL and Dual Mode TRL 6



MRM TRL6 Demonstrations





Summary



- **MRM is an integral part of the ARDEC's 120mm MCS and Abrams Ammunition System Technologies (MAAST) ATO**
- **Industry Partners - ATK & Raytheon**
- **MRM has demonstrated TRL6 for:**
 - ✓ **All major Subsystems**
 - ✓ **Integrated Autonomous Seeker Guide to Hit - 2004**
 - ✓ **Integrated SAL Seeker (Designate) Guide to Hit - 2006**
 - ✓ **Integrated Dual Mode Seeker (Autonomous & SAL) Only Guide to Hit - 2007**