Test and Evaluation/Science and Technology (T&E/S&T) Program Electronic Warfare Test (EWT) Multi-Spectral Test Technology Area

A New Approach to Aircraft Survivability Equipment (ASE) Testing

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Briefing Outline

What is Aircraft Survivability Equipment (ASE) ?

What is the Threat ?

How is the Threat Engaged ?

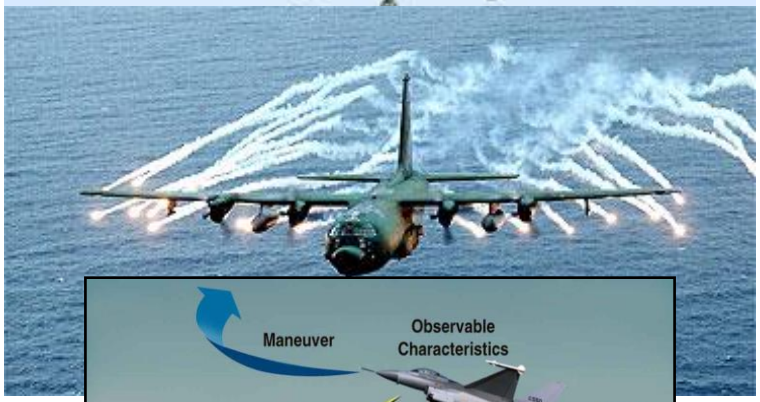
How is ASE Currently Tested ?

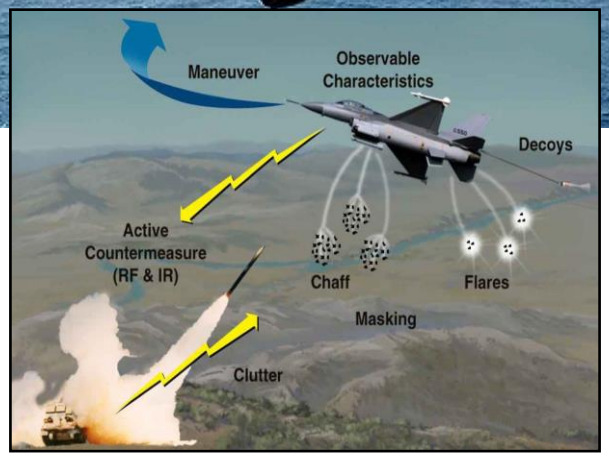
What is Needed to Better Test ASE ?

What is the MAST Program ?

How MAST is Providing for a New Approach to ASE Testing.

What is ASE ?





Today's Combat Aviation Platforms are well equipped with offensive and defensive systems.

Defensive systems include equipment designed to enable the crew and aircraft to survive threat attacks. (e.g. Aircraft Survivability Equipment)

Detect		Defeat	
Laser Warning Receiver			Chaff Dispenser
Hostile Fire Indicator			Radar Jammer
Radar Warning Receiver			Flare Dispenser
Missile Warning Receiver			IR Jammer

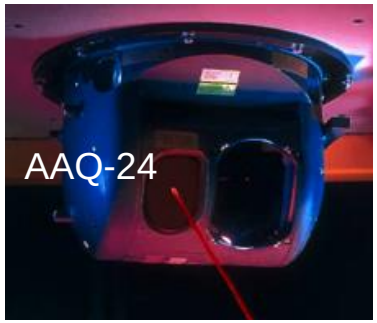
Infrared Countermeasure Suite

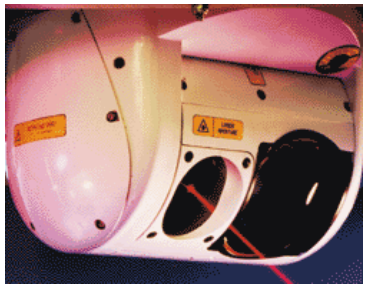
Missile Warning Systems

- AN/AAR-54 - NGC
  - UV Sensors
- AN/AAR-47 MWS - Loral/ATK
  - IR Sensors
- AN/AAR-57 CMWS - BAE
  - IR Sensors

Directed Energy Countermeasure Systems (DIRCMs)

- AN/AAQ-24 DIRCM - NGC
  - Laser Based
  - Installed on multiple platforms across services
- LAIRCM - NGC
  - AF version of the AAQ-24 with MWS for large aircraft
- DoN LAIRCM - NGC
  - Navy/Marine version of AAQ-24 with 2 color MWS & DIRCM
- CIRCM (Common Infrared Countermeasures) – NGC or BAE
  - Army PM-ASE is development lead for this Army/Navy/Marines directed energy next generation CM system



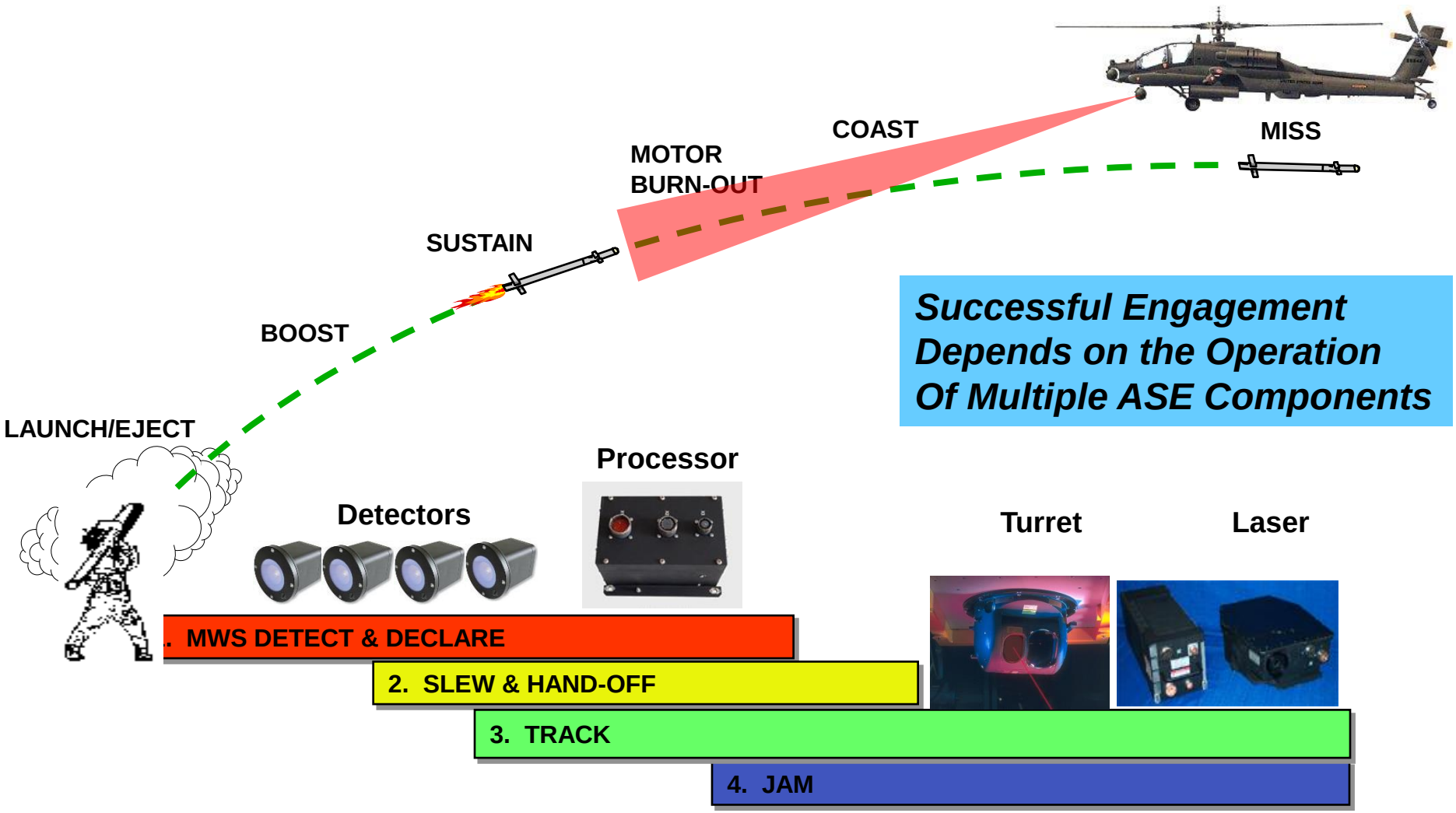


What is the Threat ?

"Man Portable Air Defense Systems (MANPADS)"

- MANPADS are readily available worldwide and capable of destroying all types of aircraft
- All major services list MANPADS as a significant threat to fixed and rotary wing aircraft
- Homeland Security considers MANPADS as a potential threat to civilian aircraft when traveling below 20,000 feet
- High cost and decreasing availability is making it more difficult to acquire threat MANPADS as test assets for ASE evaluation.

How is the Threat Engaged ?

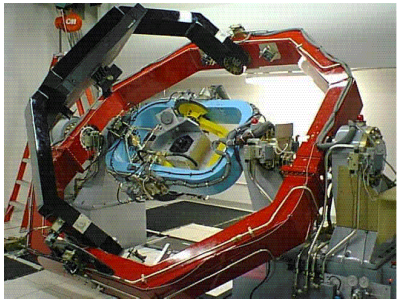


Successful Engagement Depends on the Operation Of Multiple ASE Components

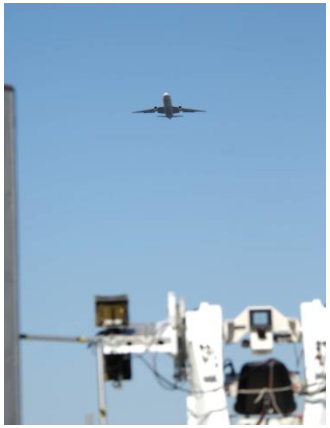
Laser IRCM System Effectiveness $P_{miss} = P_{declare} \times P_{handoff} \times P_{track} \times P_{jam}$

How is ASE Currently Tested ?

Simulated Missiles and Countermeasure
(HWIL Testing)



Simulated Missile Against Actual Aircraft on Range

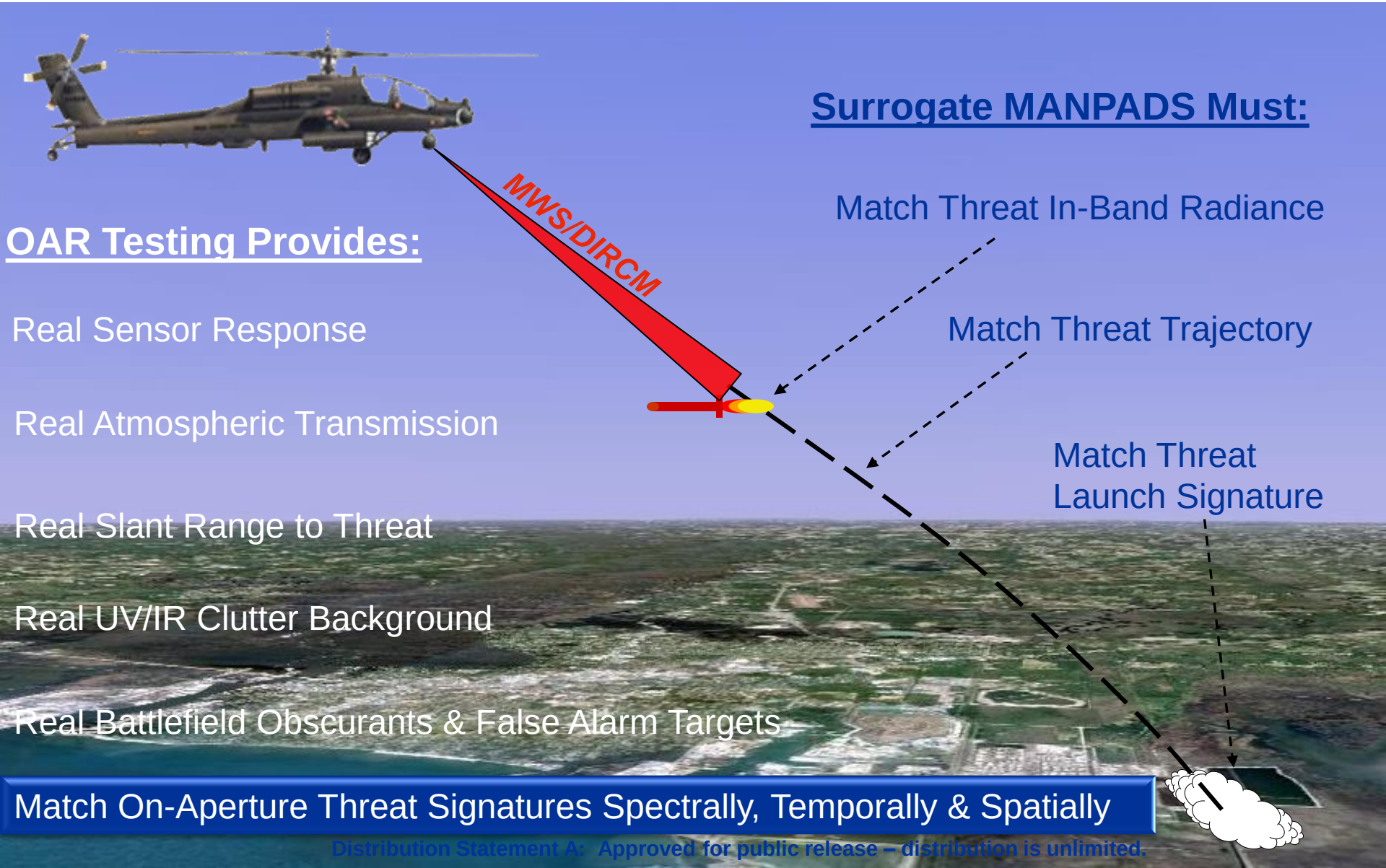


Highest fidelity testing would use an actual MANPADS against an actual aircraft with installed ASE, but Aircrew safety and asset destruction prevents this live testing.

Actual Missile Against Moving Simulated Aircraft
(Aerial Cable Car)

What is Needed to Better Test ASE ?

"Realistic Surrogate MANPADS Missiles"



OAR Testing Provides:

Real Sensor Response

Real Atmospheric Transmission

Real Slant Range to Threat

Real UV/IR Clutter Background

Real Battlefield Obscurants & False Alarm Targets

Surrogate MANPADS Must:

Match Threat In-Band Radiance

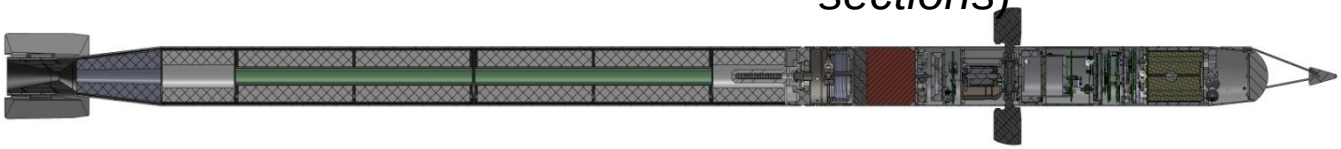
Match Threat Trajectory

Match Threat Launch Signature

Match On-Aperture Threat Signatures Spectrally, Temporally & Spatially

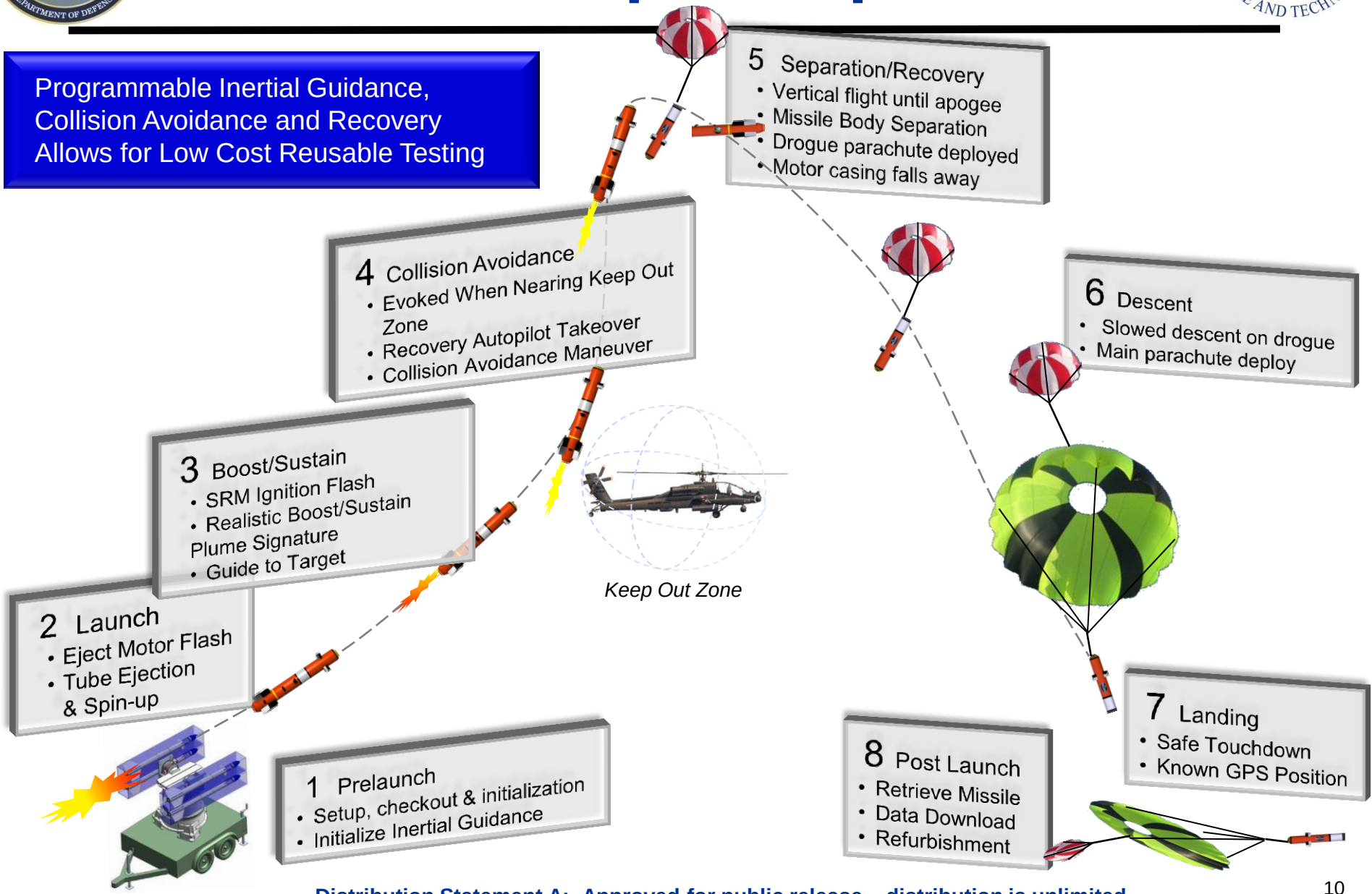
What is the MAST Program ?

- MAST is a joint S&T program sponsored by the OSD Test Resource Management Center (TRMC) and the U.S. Army Aviation Missile Research Development and Engineering (AMRDEC).
- The objective of MAST is to develop and demonstrate a surrogate MANPADS missile system that:
  - Emulates the actual threat IR/UV signature spectrally, spatially and temporally ("*Looks like the threat*")
  - Flies a similar trajectory to the actual threat ("*Flies like the threat*")
  - Provides non-destructive testing (*Collision avoidance*)
  - Provides for lower cost testing (*Low Cost motors and Recoverable avionics sections*)

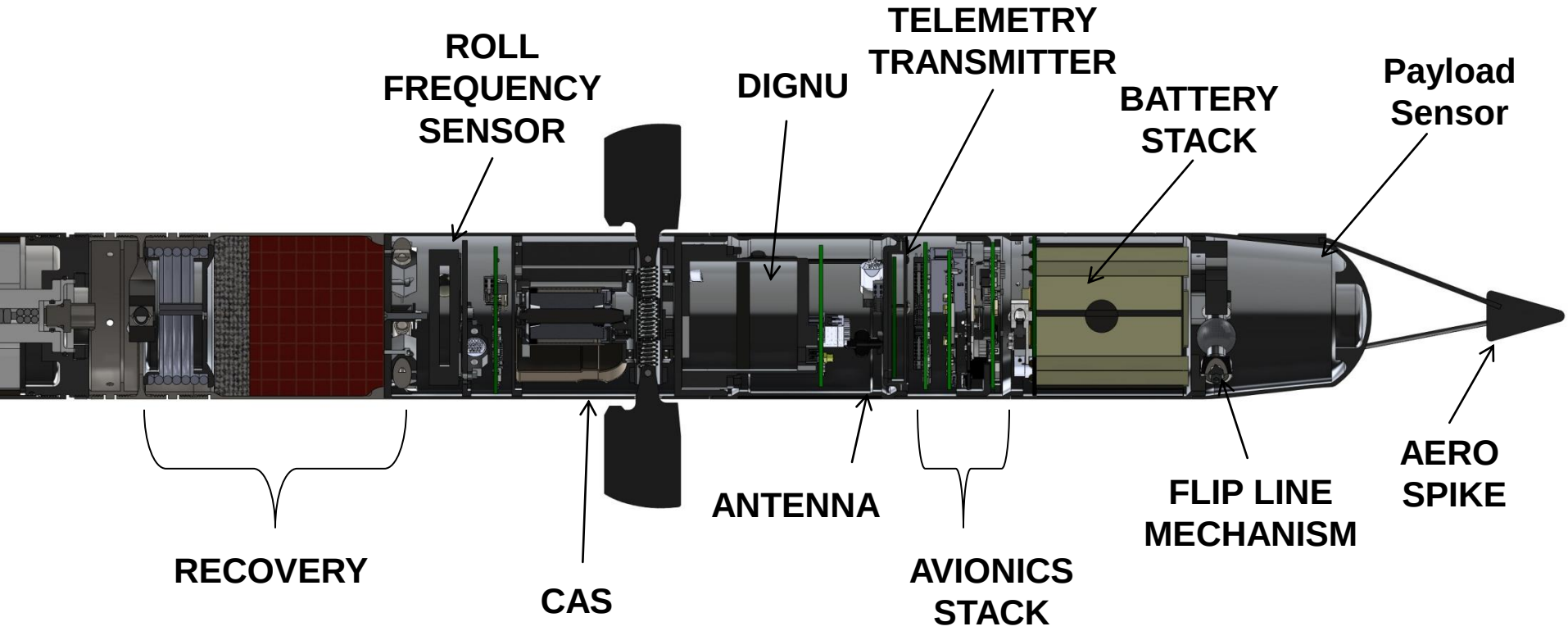


MAST Concept of Operations

Programmable Inertial Guidance, Collision Avoidance and Recovery Allows for Low Cost Reusable Testing



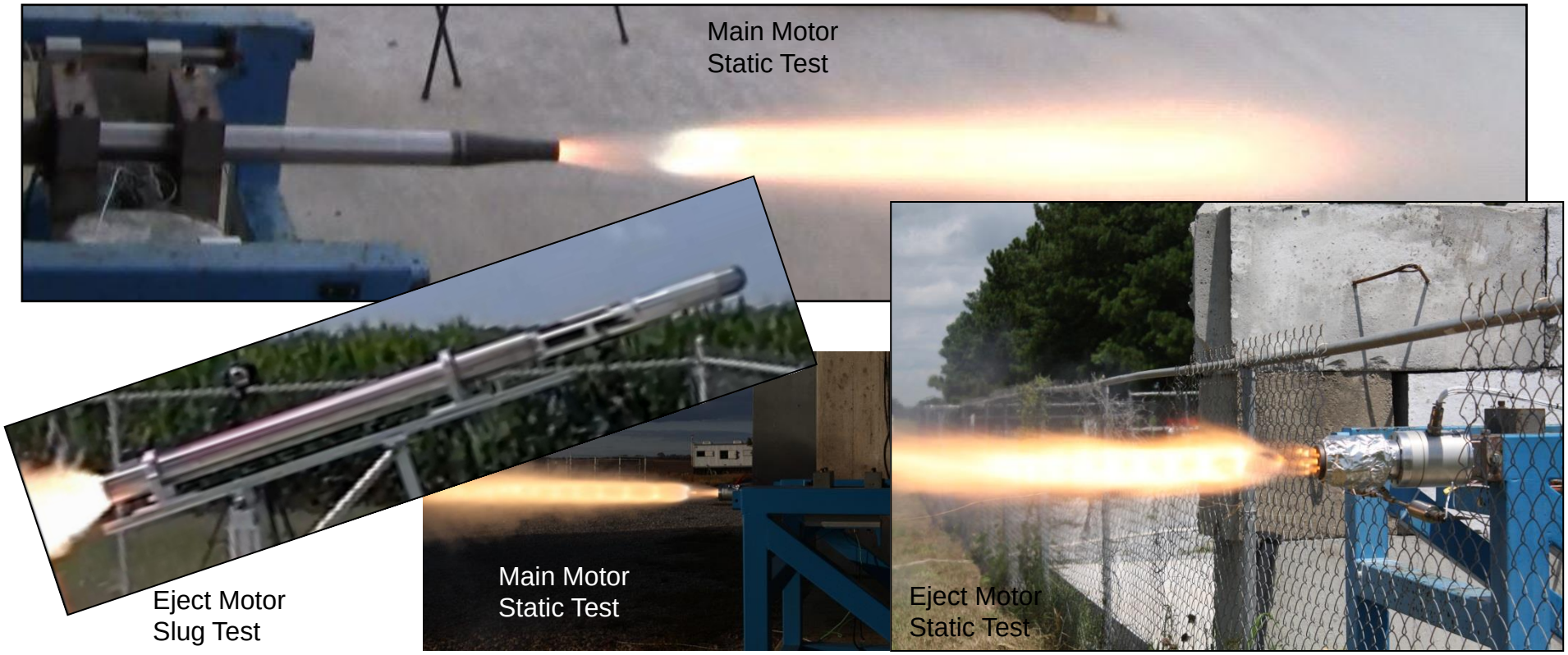
Missile Airframe Design



Eject and Main Motors
"Look Like" the Threat

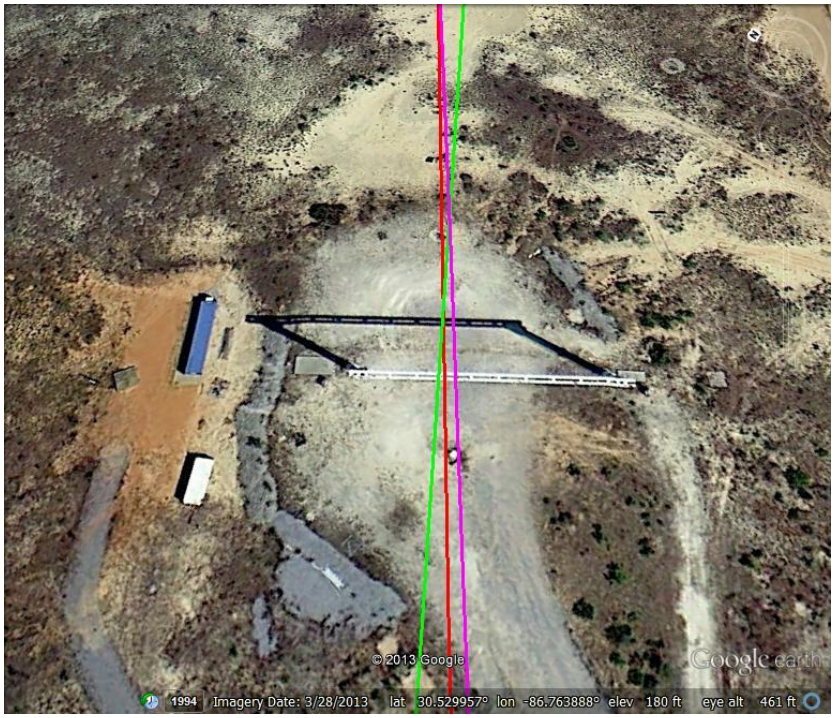
MAST is developing low-cost Eject Motors and Solid Rocket Motors (SRMs) That "*Look Like*" the threat missile in the UV and IR bands.

- Using commercial motor propellant formulas and fabrication processes
- Designed to match the threat spectral, temporal and spatial characteristics
- Extensive static testing and signature collection/analysis performed to match MANPADS motor signatures and thrust prior to flight testing.



Inertial Guidance of a Rolling Airframe "*Fly Like*" the Threat

- MAST flies a closed loop proportional navigation (ProNav) trajectory similar to the actual threat
- Demonstrated successful inertial guidance of a rolling airframe missile using the Honeywell Deeply Integrated Guidance and Navigation Unit (DIGNU) to provide IMU and flight computer.



Comparison of End Game for Recent Guided Flight at Eglin, AFB

Green – Simulation
Red – EDIGNU Estimation
Pink - Radar

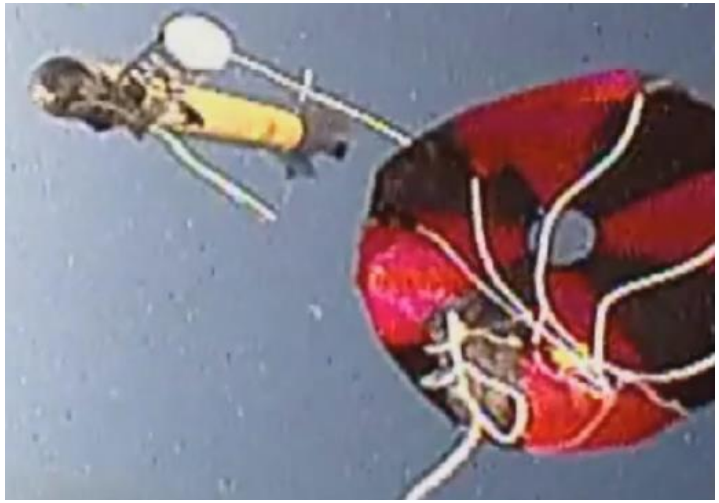
DIGNU

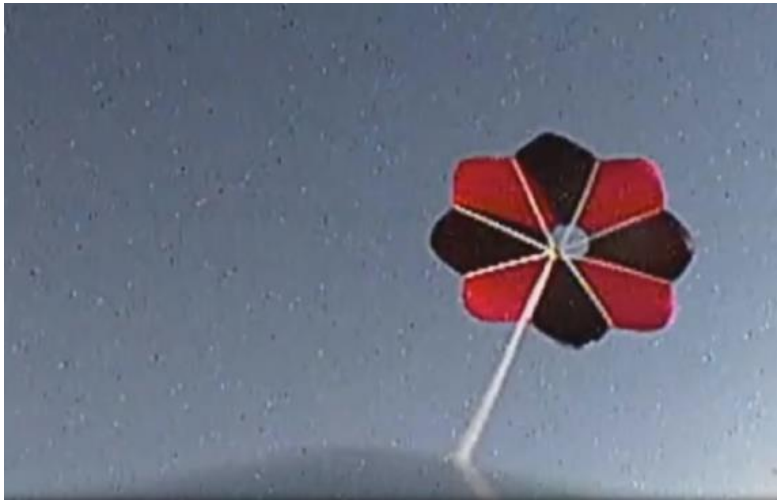
Future versions of MAST Will utilize Honeywell HG1930N

HG1930N

- More Accurate & Faster
- Smaller & Less Power/Heat
- Commercial & Cheaper

Missile Separation





Mid-Body Separation and Recovery Demonstrated on 10 Flights to Date

Safe Recovery & Reuse of MAST Avionics Sections Reduces Test Costs

Safe Recovery of Guidance Section from A Guided Flight Test in December 2013

Safe Recovery of Guidance Section from A Ballistic Flight Test in December 2011 (Drogue and Main Chute in Upper Left)

Safe Recovery and Reuse of Avionics Section Proven in Multiple Flights

MAST Development Partners

AMRDEC
Development Lead
S&T Dev Funding

OSD TRMC
S&T Dev Funding

AEgis Technologies

Dynetics

PM ITTS
Executing Agency

PEO IEW&S
PM IRCM
ASE Requirements
Dan Jones
Sergio Cafarelli

MSIC
Threat Information,
Signature Verification,
Launcher - Gary Vincent,
Lori Keaty, Mickey Elkins,
Rodney Ratlidge

TSMO
Threat Assets
(Seekers and
TSPILS Simulator)
Jerry Touchton

46th Test Wing
Flight Testing
Ronnie Sookoo
David Misita

AMCOM
Safety Office
Brett Smith
Bob Mulkey

MAST Program Status

- Program Kickoff (Jun 2010)
- Phase I Flight Testing (Jun 2011)
  - 3 Missile Flight Tests at Eglin AFB demonstrated successful separation and recovery
  - Used Stinger eject motors and main motors
- Phase I Flight Testing (Dec 2011)
  - 3 Missile Flight Tests at Eglin AFB demonstrated avionics and DIGNU (IMU) survival through launch shock/accelerations
  - Demonstrated successful separation & recovery on all flights
- Phase II Flight Testing (Dec 2013)
  - 4 Missile Flight Tests at Eglin AFB demonstrated new low cost Eject Motors and Solid Rocket Motors
  - Guided Flights demonstrated inertial proportional navigation
  - Missile Warning System and Radiometers captured in-flight signatures
- Phase II Extension Pending (Jun 2014 – May 2015)
  - Army user requested additional refinements to signatures and incorporation of latest IMU technology (HG1930N)
  - S&T Graduation after 4 flight tests in May 2015
- 1st Production Lot Pending (Jun – Aug 2015)
  - Eject Motors, Solid Rocket Motors and Avionics Sections requested to support Army sled testing and flight testing for the CIRCM program
- CTEIP Submittal Pending (FY16)
  - Incorporate produce-ability modifications, additional threat variants and build production missile for all 3 services

MAST Video

Other Test Applications for MAST Technologies

- **Recoverable MAST missiles can be used as a bus to provide a ride for developmental payloads**
  - Seekers, IMUs, fuzes, warheads, etc.
- **Guidance & Control Technology can be reused to fly a wide range of surrogate target missiles**
  - Any size from 2.75” up to 24” diameter
  - Rolling or non-rolling airframes
  - Inertial or GPS guidance
- **Non-recoverable short range versions being considered for testing ASE on manned aircraft**

Acknowledgement / Disclaimer

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