*NDIA 47th Annual Fuze Conference*

# *Weapon Fuzing / Safety & Arming Programs Overview*

# *NSWC / Indian Head Division*


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*Fuze Safety & Arm Branch Lead*


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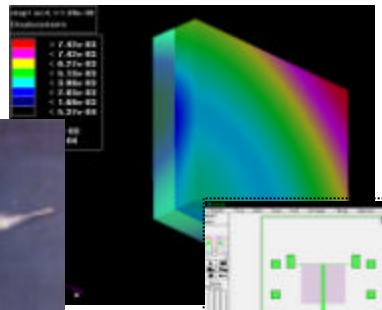
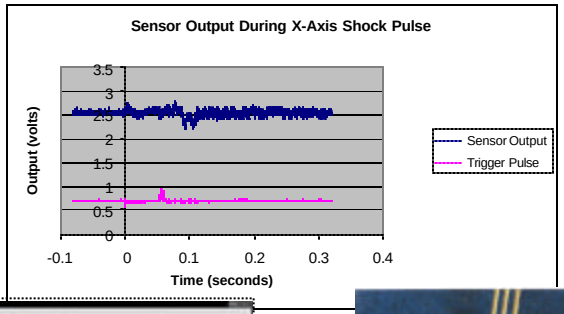
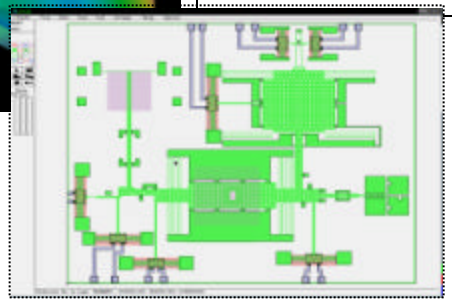
# *OUTLINE*

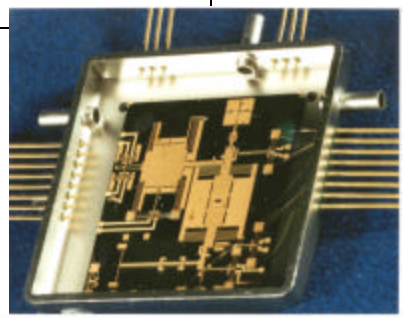
FY02-03

- CCAT Development Program
- Technology Programs
- SMAW-NE
- Agent Defeat ACTD
- Summary







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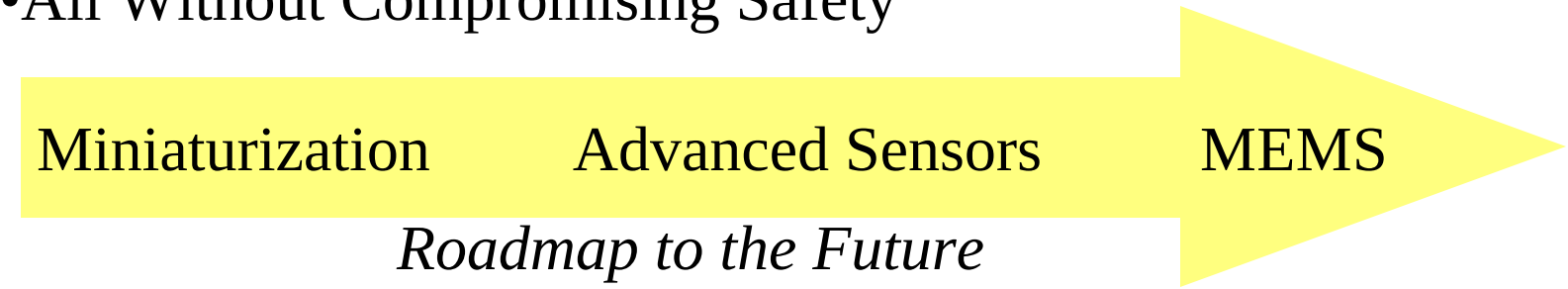
## "*Enhancing Weapon Performance*"

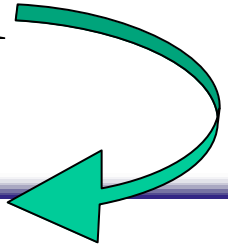
What Does This Mean To The Fuze Community?

- Smaller
- Smarter
- More Reliable
- Cheaper
- All Without Compromising Safety




*Roadmap to the Future*

Enhancing Weapon Performance @ NSWC / IH



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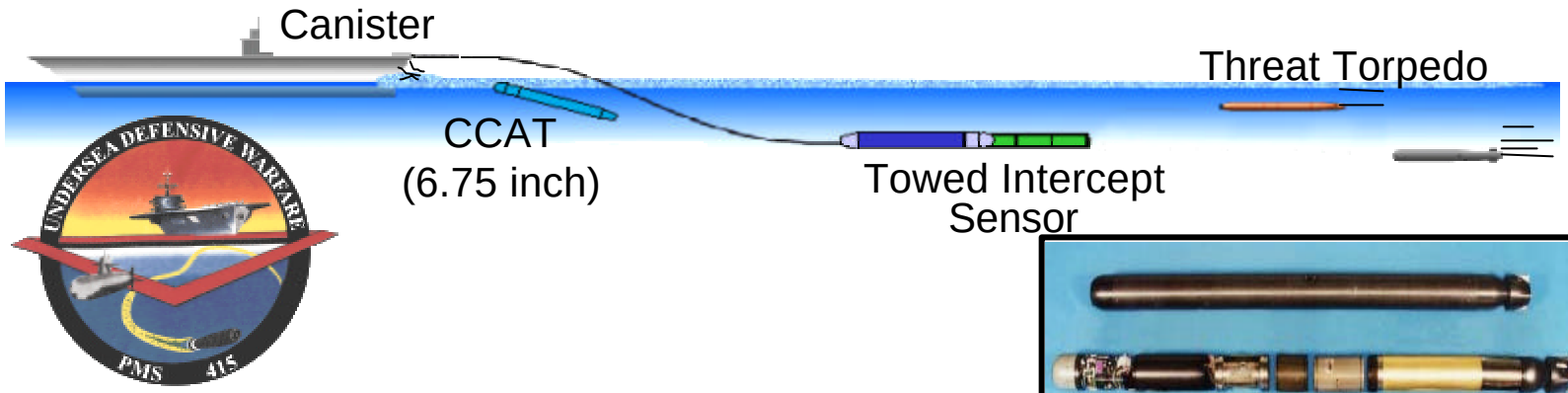
# Canistered Countermeasure Anti-Torpedo (CCAT)




•CCAT System Development & Demonstration (SD&D) Program – FY04 start

- **Smaller, Lighter Fuze/S&A**
- **Increase S&A safe-separation accuracy**
- **Modular Architecture: adaptable to multiple platforms (sub & air) and missions**
- **Lower Total Ownership Cost for the Fleet**
- **Safety – Mil-STD-1316 complaint, fail-safe design**

MEMS & Miniature EFI

Advanced Sensors, Flow & IMU



**6.75” CCAT S&A/ Exploder**
**15 in$^3$**

**MK 48 Torpedo**
**MK 21 Exploder**
**118 cu in**

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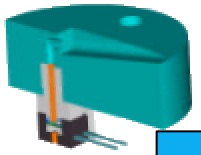
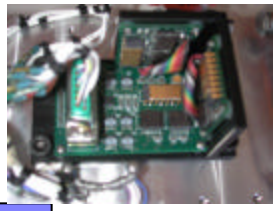
# *NAVY MEMS-BASED F/S&A (EXPLODER) PROGRAM*
## *System Architecture*



**COTS DPS… Torpedo Applications Brief, Session III**

**S&A Sensors**



**S&A Electronics**

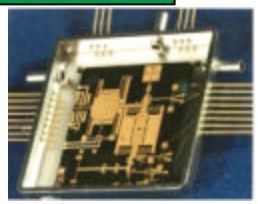
**Initiation System**

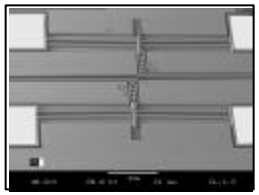
- **Fire-Set**
- **Slapper**
- **Explosive Leads**

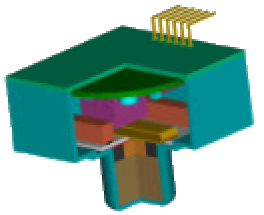
**Safety & Arming Chip**

**Optical Charging System**

**CCAT S&A Development Brief, Session IV-B**







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# *NAVY MEMS-BASED F/S&A TECHNOLOGY PROGRAM*

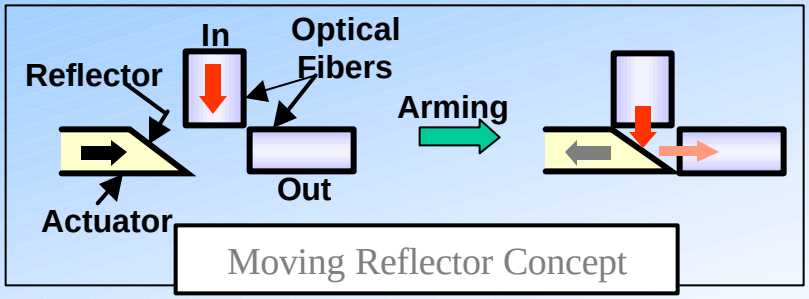
## *High Power MEMS Optical Switch Effort*

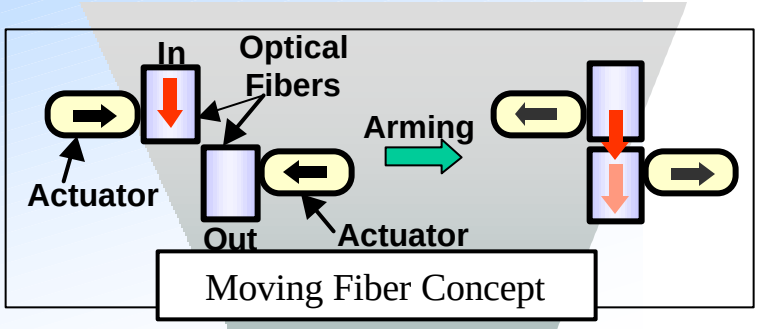
Objective:

• Design, fabricate & characterize a fail safe MEMS optical switch for energy interrupt on S&A chip

Approach:

• Investigated two switch design concepts,



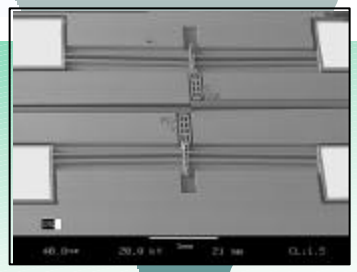




Status:

• Characterize design variants of both concepts

• Down-selected to fiber alignment design

• Demonstrated 87% optical power transfer efficiency with 2000 mW input



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# *NAVY MEMS-BASED F/S&A TECHNOLOGY PROGRAM*

## *IMU for Close-In Ship Defensive*

OBJECTIVE:

•Adapt a low cost, small volume Inertial Measurement Unit (IMU) for use in torpedo S&A devices

Approach:

• Leverage DoD investments in IMU technology to utilize advanced sensors for torpedo application

•STATUS:

• Sea, land & air gun tests completed for using COTS IMU

• Conducted laboratory evaluation of commercial IMUs

• Conducting IMU performance analysis to characterize CCAT safe separation measurement

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# *INTEGRATED INITIATOR EFFORT*

Objective:

- Develop Miniaturized,Low-Cost, Integrated, High Voltage Slapper Initiation System

Approach:

- Team with DOE (Honeywell F&MT) to develop Advanced Miniature High Voltage Initiation System
- Integrate all high voltage lines into package, minimize input requirements…power, ground, trigger signal, system on
- Small total size…~1 cu in

Status:

- Completed Phase I initiation system functional & explosive performance & characterization tests (125)
- Executing Phase II, refining fire-set, slapper & explosive component design to reduce parts & assembly steps
- Integrating into dual point initiated CCAT warhead

# *MEMS F/S&A TECHNOLOGY PROGRAM*

**Micro Detonics – Enabling Technology for next generation of MEMS S&A**

OBJECTIVE :

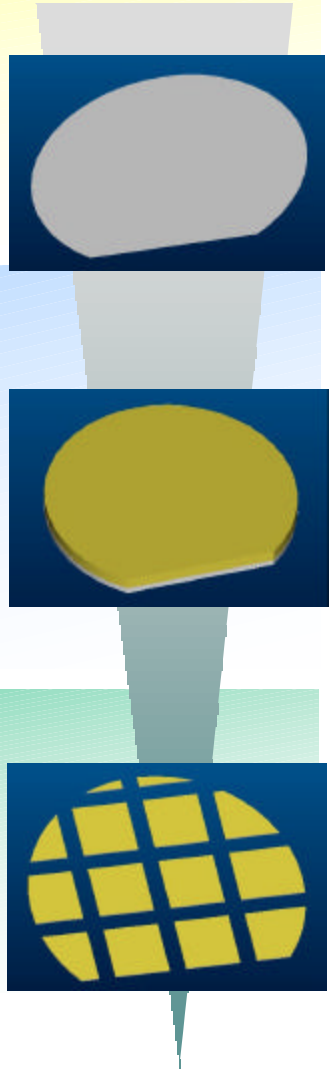
- Develop the enabling explosive material & manufacturing technology to produce low-cost, reliable on chip MEMS detonator

APROACH :

- Investigate the use of thin film explosives that are formed *in situ* on silicon (MEMS) devices
- Leverage MEMS industry manufacturing technology to develop batch process for high volume, low cost & repeatable batch process

STATUS :

- Formed thin film explosive samples & conducted proof of concept qualitative tests
- Explosive characterization testing scheduled this FY



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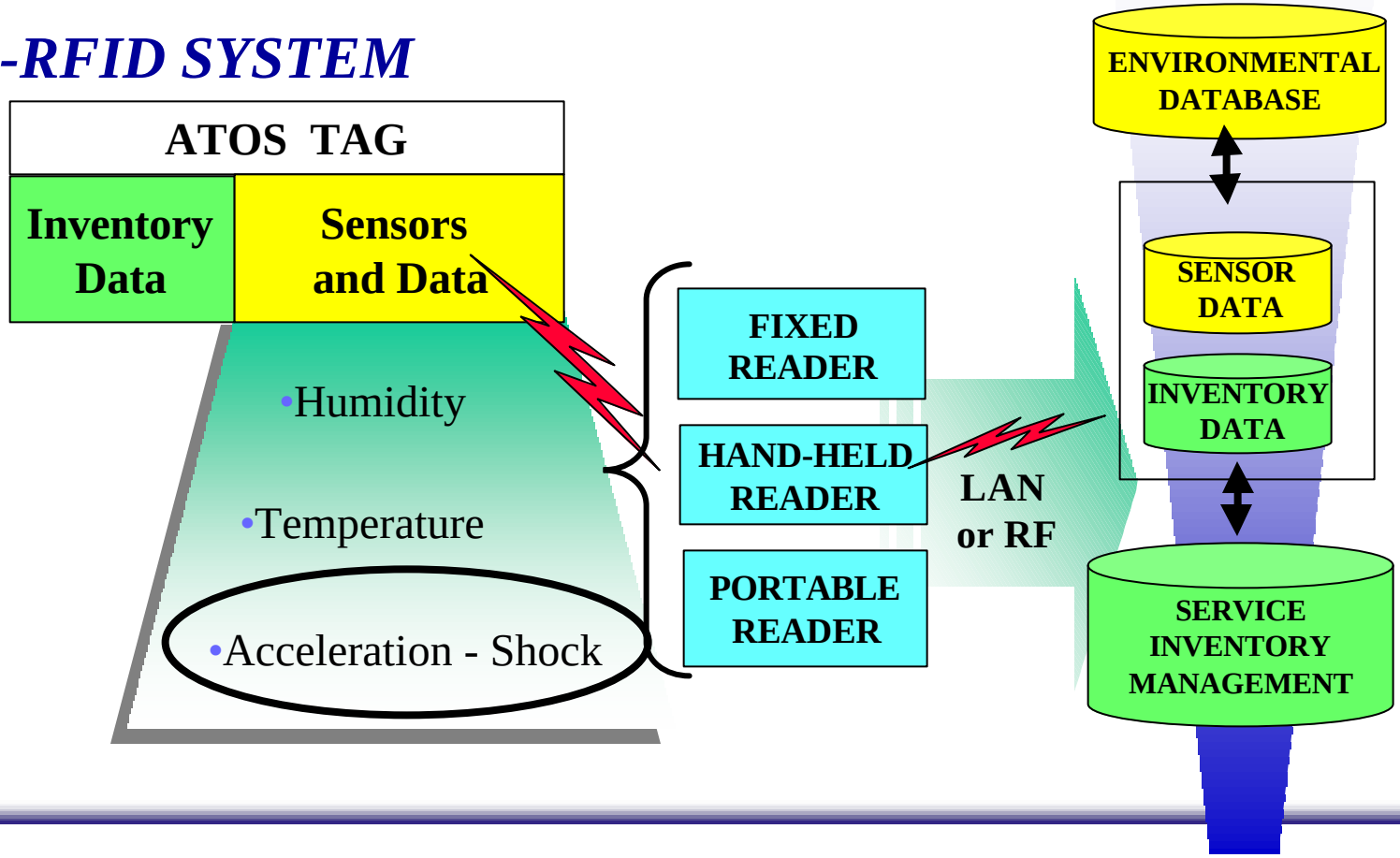
*NSWCIH patent pending*

# *ADVANCED TECHNOLOGY ORDNANCE SURVEILLANCE (ATOS)*

- Advanced Concept Technology Demonstration – FY 01 - 03
- Demonstrate operational utility of miniature radio frequency identification (RFID) tags coupled with micro-electromechanical sensor (MEMs) technology for use in tracking/monitoring critical items

## *ATOS-RFID SYSTEM*

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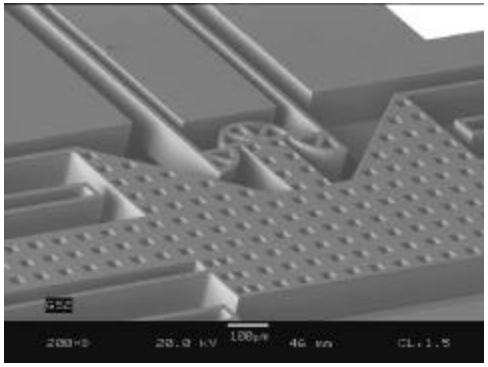
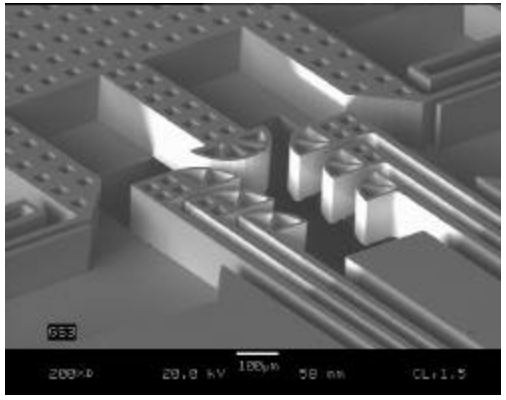
# *ATOS-RFID SYSTEM*
# *Integrated MEMS G-Sensor(s)*

- Spring supported mass deflects into latch when G-Sensor undergoes a defined shock.
- ATOS-RFID records shock event when G-Sensor latched



Latched Sensor



Multi-Level Sensor

## Status of Sensor Development

- Five design iterations completed to date.
- Over 500 working devices fabricated.
- All sensors tested have been accurate to within ±3%.

## Sensor Attributes

- No power needed to record shock.
- Can be electronically reset.
- Latch levels from 25 to 1500 gs.
- Advanced designs include multi-level and multi-directional.
- Sensor size: 6 by 3 mm.

*NSWCIH patent pending*

# *MEMS TECHNOLOGY INVESTMENT*

## Indian Head NSWC MEMS Clean Room

**Navy facility for Integrating MEMS, Electronics and Explosives**

- **Officially opened 29 Aug, 2001**
- **Class 10000 Cleanroom**
- **Explosive and MEMS Assembly**
- **Characterization**
- **Testing**
- **800 Sq. Ft inert processing space expansion begun late in FY02**
- **Planned Capital investment for Detonic Technology Development**


~800 sq. ft workspace


Explosive Test Chamber

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# *ACKNOWLEDGEMENT OF PARTNERS IN MEMS TECHNOLGY DEVELOPMENT*

- **MEMSCAP**
  - **MEMS and slapper foundry processing**
- **Honeywell F&MT**
  - **Miniature Fireset and Optical Interrupt**
- **Applied Physics Lab – JHU**
  - **Packaging and processing**
- **University of Maryland**
  - **Optics and packaging R&D**
- **Tanner Laboratories**
  - **Energetics and MEMS Development**
  - **CRADA established**
- **Applied Research Lab @ Penn State**
  - **Integration of MEMS S&A into CCAT**

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# *ADVANCED SENSOR TECHNOLOGY PROGRAM*

## *ONBOARD ENVIRONMENTAL SENSOR SYSTEM For ENHANCED PERFROMANCE Of An UUV/TORPEDO*

Objective:

- Develop a Miniaturized Conductivity-Temperature-Depth (CTD) Sensor System for UUV Applications. Resulting Environmental Data Used in Computing Localized Speed of Sound and Compared preprogrammed global Speed of Sound Assumptions for Determining Homing and Fuzing Performance.

Approach:

- Use COTS Sensors to Develop & Demonstrate a Multi-Sensor Integrated System
- System Should be UUV/Torpedo Compatible
- Maximum Size -- 12 Cubic Inches

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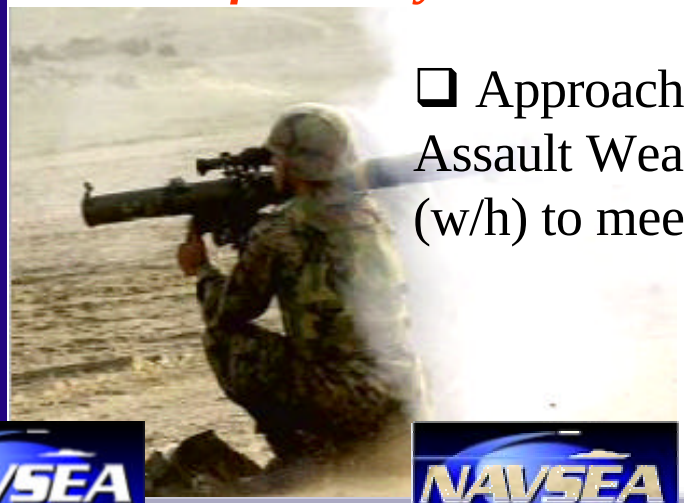
# *SMAW-NE (RAPID RESPONSE) ACQUISITION EFFORT*

## Program Information

- 1st Marine Division Issues User Needs Statement (UNS) – ( 6 Nov '01)
  - ❑ Urgent requirement to support Operation Enduring Freedom & future operations overseas
  - ❑ Requirement – "A stand-off capability to effectively engage enemy forces using cave/tunnel networks of cover. The capability should also be applicable to Military Operations in Urban Terrain … ***could be used to defeat everyone within a two story house and collapse the structure"***



  - ❑ Approach – Use Shoulder-Launched Multipurpose Assault Weapon – SMAW system & design new round (w/h) to meet requirement

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Talley Defense Systems

Action

# *SMAW-NE (RAPID RESPONSE) ACQUISITION EFFORT*

## Team

- MCSC task IHDIV to lead technical team to,
  - ❑ 1st demonstrate SMAW NE (Phase I, Feb – Jul ’02) concept
  - ❑ Then to produce units for safety (Hazard Assessment, Safety Survivability, Man rating, Safe Separation), LUT (Limited Users Tests), Pendleton Demo & performance testing, training, and fielding. (Phase II, Sep ’02 – Jan ’03)
  - ❑ Team members

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Talley Defense Systems

Action

## Program Overview

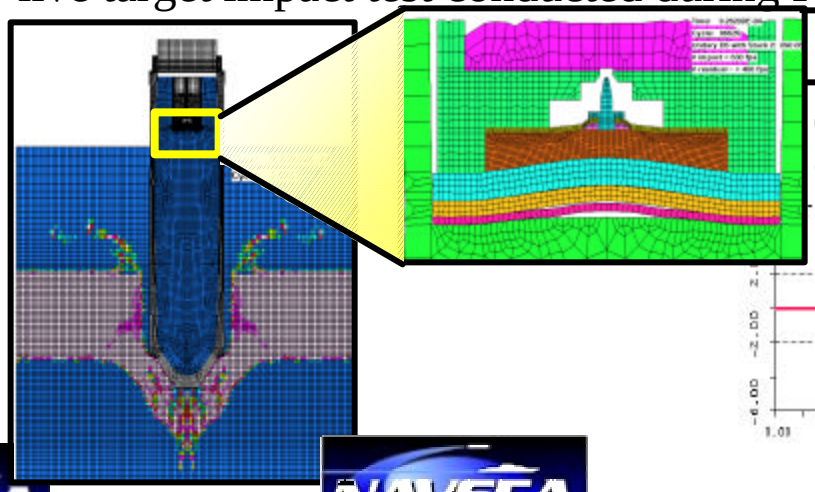
- Utilize hardware assets from SMAW-HEDP FY02 production
  - ❑ MK 119 Rocket unmodified
- Redesign warhead to penetrate urban i.e. brick structures & optimize explosive fill to achieve required lethal effect
  - ❑ HEDP W/H designed to penetrate sand bag & earthen bunkers
- Integrate baseline MK 420 Fuze into “new” system … ***& here is the devil in the details***

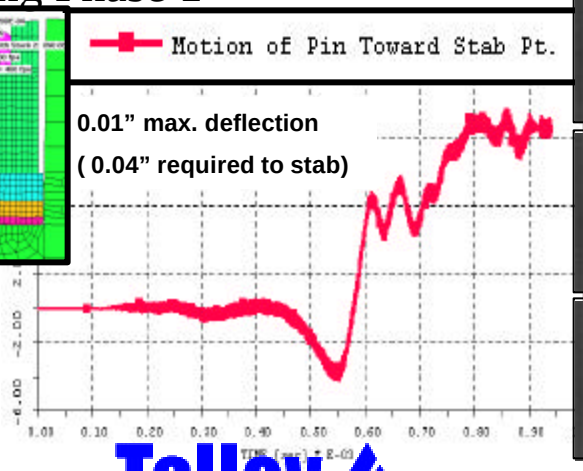
# *SMAW-NE (RAPID RESPONSE) ACQUISITION EFFORT*

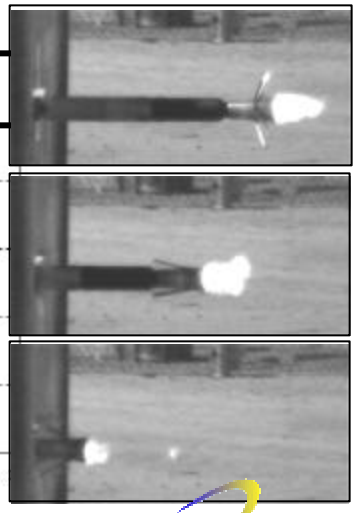
## Fuze Integration

- Safety Issue – Design modification required to increase minimum arming distance beyond NE round safe separation distance
  - ❑ Added mass escapement pallet & re-designated Fuze as MK 420 MOD 1
- Reliability Issue – Increased round weight reduced arming set-back load
  - ❑ Quantify maximum round weight
- Maintain dual mode Fuze function
  - ❑ Attenuate hard target stimulus into Fuze – 2 iterations of analysis & live target impact test conducted during Phase 1

MK 420 Fuze shown with shield removed





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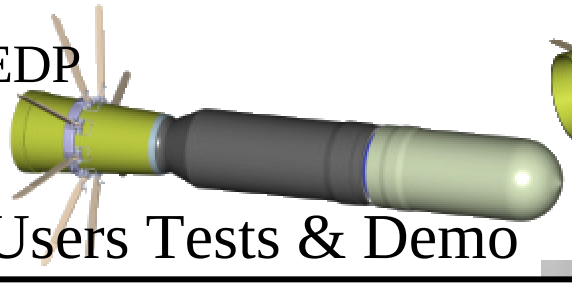
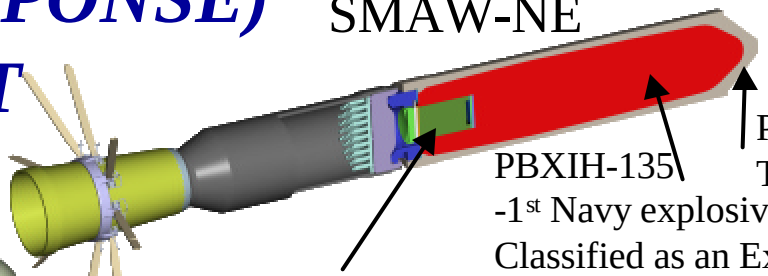
# *SMAW-NE (RAPID RESPONSE) ACQUISITION EFFORT*

SMAW-HEDP

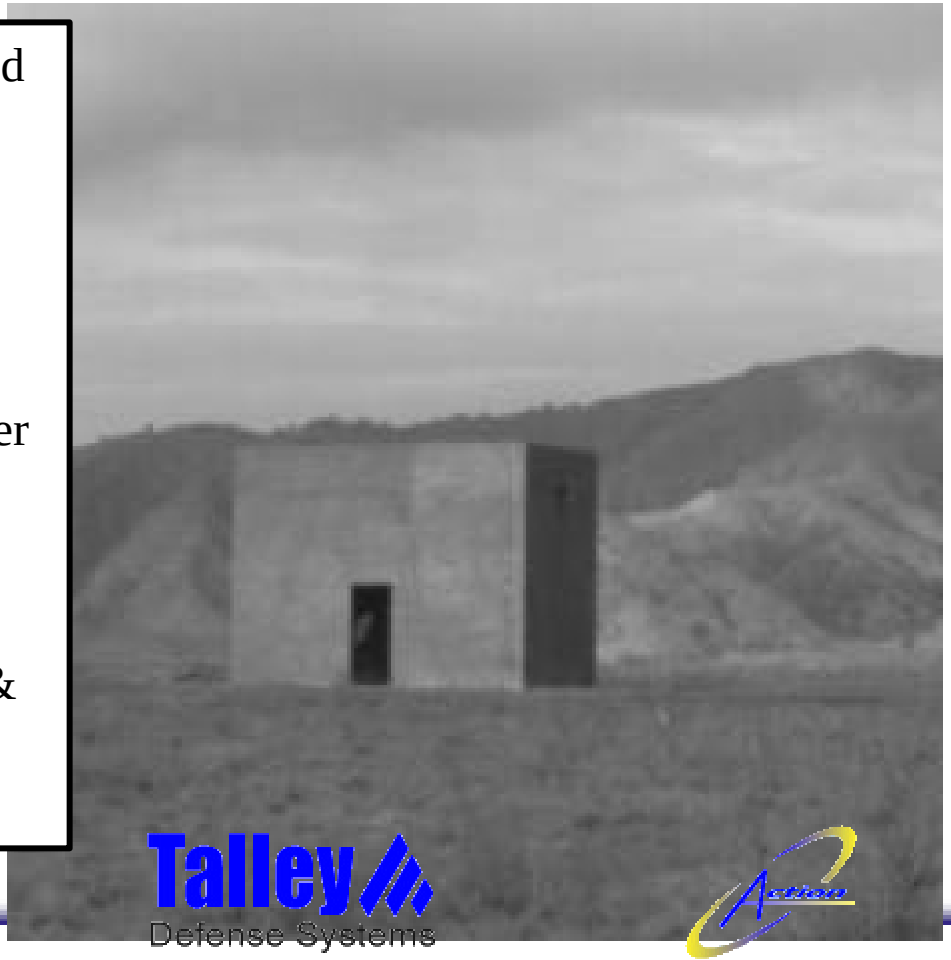


SMAW-NE




## Limited Users Tests & Demo

- SMAW gunners successfully launched 30 live rounds @ Pendleton
- Lethality demonstrated by SMAW gunner engaging two story structure
  - ❑ structure size 12’ x 20’ x 16’
  - ❑ single brick (solid-8000psi) over plywood and 2”x4” stud walls
  - ❑ single entry door
  - ❑ One window & door / floor
  - ❑ floor structure between lower & upper level
  - ❑ flat roof structure



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# *AGENT DEFEAT ACTD*

Program Structure:

- Navy Lead Joint Air Force / Navy ACTD
- Industry Partner – Lockheed Martin
- 30 Month program

Objectives:

- Demonstrate ability of High Temperature Thermal Radiating (HTTR) material to defeat chemical & biological agents
- Demonstrate payload delivery system using BLU-109 JDAM weapon system
- Demonstrate expulsion & dispense of payload within confined target space

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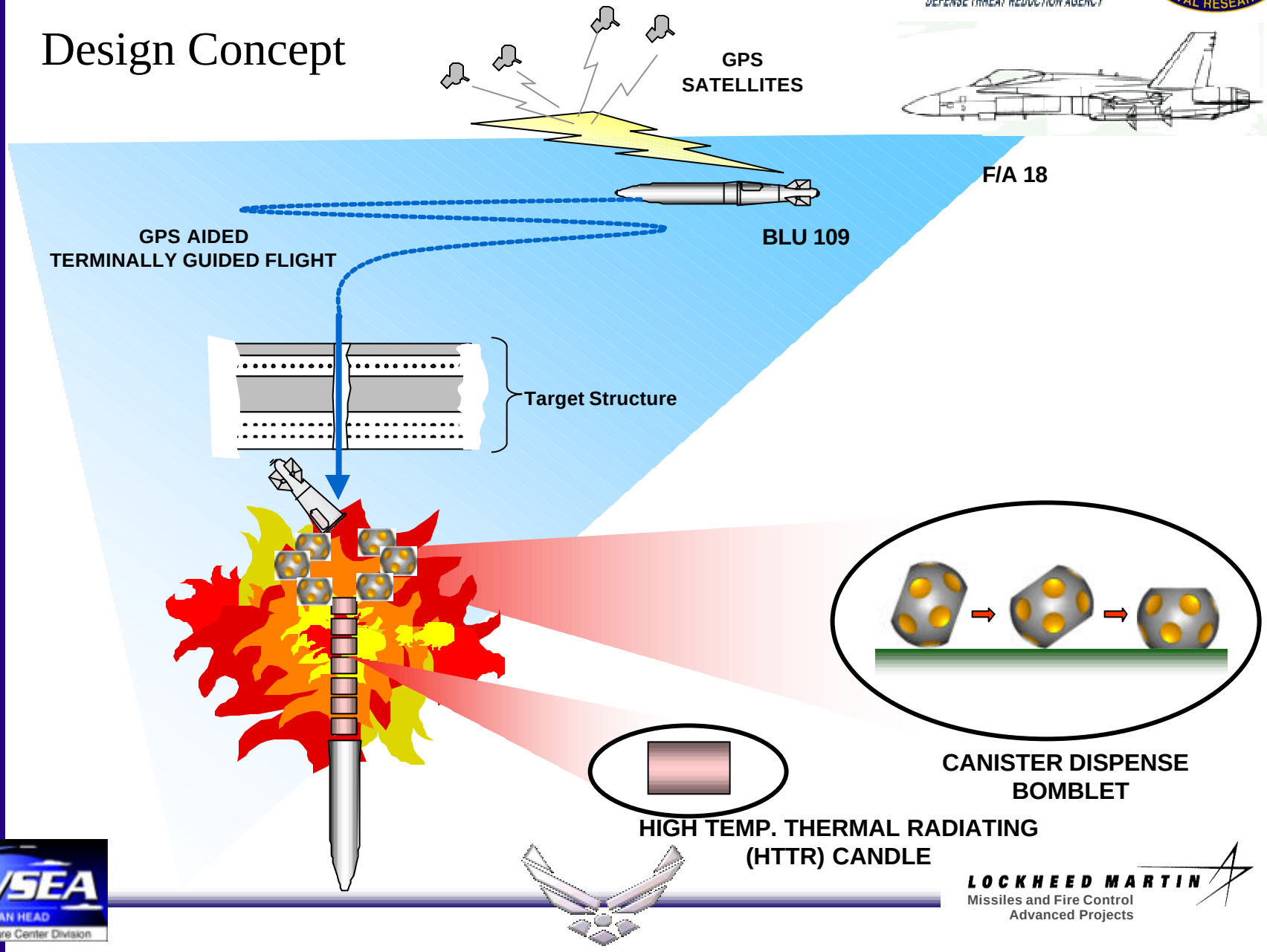
LOCKHEED MARTIN Missiles and Fire Control Advanced Projects

# AGENT DEFEAT ACTD

## Design Concept




DTRA DEFENSE THREAT REDUCTION AGENCY

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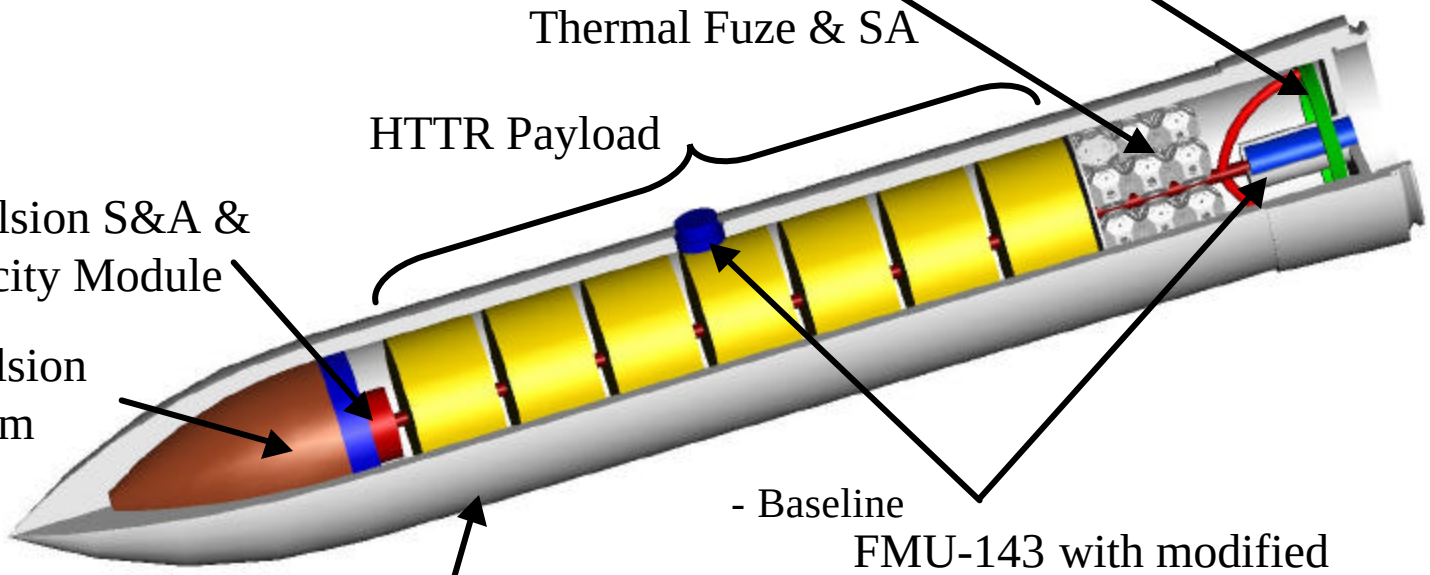
LOCKHEED MARTIN
Missiles and Fire Control
Advanced Projects

# AGENT DEFEAT ACTD

## Fuze Systems & Energetics




- Baseline
  FMU-143 with modified explosive output & FZU-32
- Future Option
  FMU-159 with modified explosive output & FZU-60

# *SUMMARY SLIDE*

OBJECTIVE :

- Provide developmental and S&T capability for Enhancing Weapon Performance

APROACH :

- Secure S&T investment in Advanced Sensor, Miniaturized (MEMS) & Modular S&A Architectures, and Miniaturized Energetics
- Develop joint DoD technology roadmap (Fuze IPT action)
- Pursue joint (DoD & DoE ) collaborative technology development (Fuze IPT action)
- Maintain Fuze system safety (i.e. adhere to MIL-STD-1316 etc.) & reliability

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