Navy Fuze S&T and Acquisition Strategy

56th Annual NDIA Fuze Conference

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Outline

- **Navy Weapon Structure**
- **Navy Fuze Acquisition Overview**
- **Navy Fuze S&T Overview**

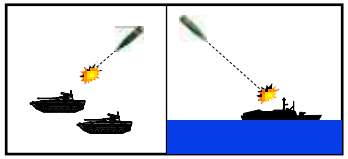
Navy Weapon Structure

Chief of Naval Operations
ADM Jonathan Greenert

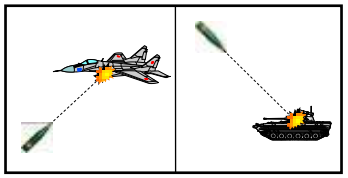
5-Inch Gun Fuzes

- MK 432 Electronic Time (ET)
  - First production 2002
  - Navalized version of M762A1
  - ET only, no PD backup
  - Used on KE-ET & HE-ET (ASuW close in)
- MK 437 Multi Option Fuze Navy (MOFN)
  - First production 2011
  - Navalized version of M782 MOFA
  - ET, PD, PD Delay & HOB
  - Land Attack & ASuW; no AAW
  - Used on MK 186 HE-MOF
- MK419 Multi-Function Fuze (MFF)
  - First production 2004
  - USN Unique Fuze
  - ET, PD, Surface & AIR Prox, AUTO
  - Selectable HOB
  - Rain Reliability
  - Sea Clutter Filter – AIR
  - Land Attack, ASuW, & AAW

Electronic Time (ET)

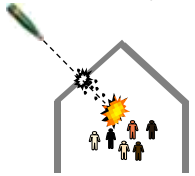


Point Detonating (PD)

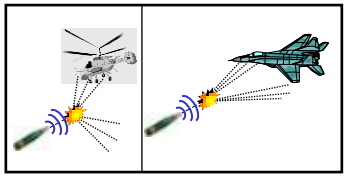


Surface Proximity (HOB)

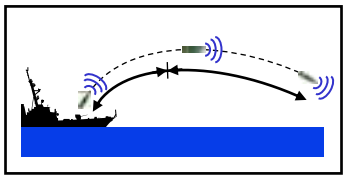
PD Delay



Air Proximity (AIR)



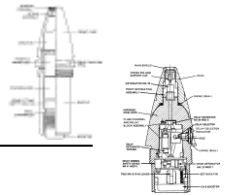
Autonomous (AUTO)



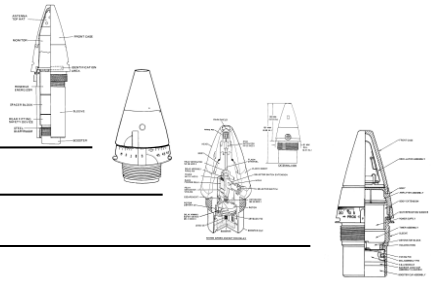
5-Inch Gun Fuze Roadmap

PAST | 2003 | CURRENT | FY16 | BYND FYDP

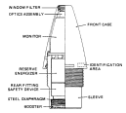
MK91 Mod 1: Infra-Red
MK399 Mod 0: Point Detonate



MK73 Mod 11/13: Variable Time
MK342 Mod 1: Mechanical Time/Point Detonate
MK407 Mod 1: Point Detonate/Delay
M732: Controlled Variable Time



MK404 Mod 1: Infra-Red



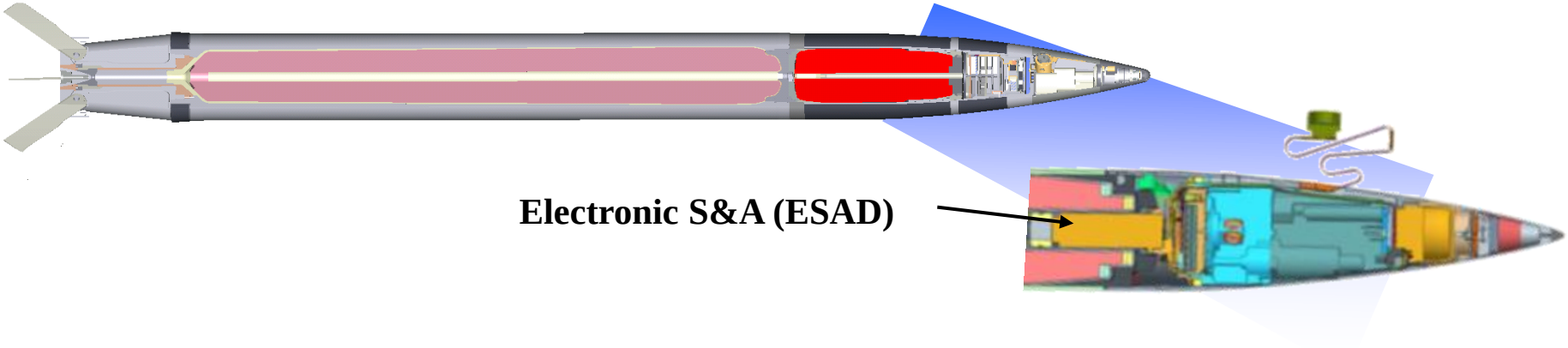
MK419 Mod 0: Multi-Function Fuze
MK432 Mod 0: Electronic Time

MK419 Mod 1: Multi-Function Fuze
MK437 Mod 0: Multi-Option Fuze Navy

OBSOLETE
OBSOLESCENT/SUSTAINMENT
ACTIVE/FUTURE

Navy Guided Projectiles

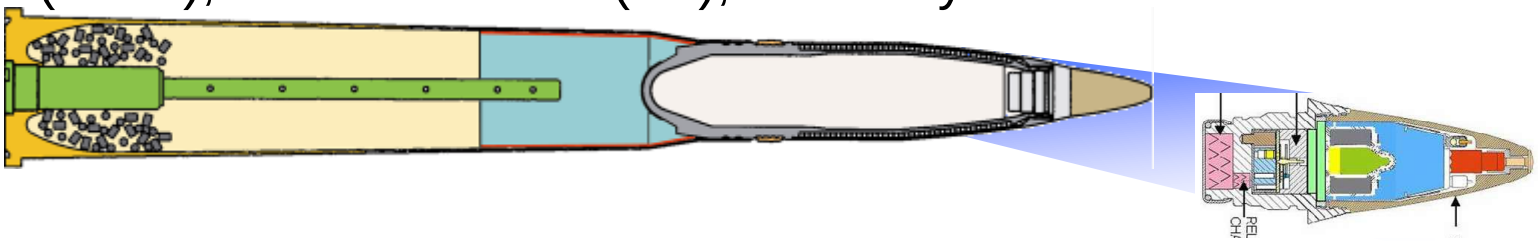
- 155mm Long Range Land Attack Projectile (LRLAP)
  - Gun-launched, rocket-assisted guided projectile
  - Currently in SDD phase as part of the Advanced Gun System on DDG-1000 Class destroyers
  - Qualification and guided flight testing underway, completion scheduled in 2013
  - LRIP to begin in FY14
  - Range > 63nmi
  - Electronic S&A and electro-mechanical ISD



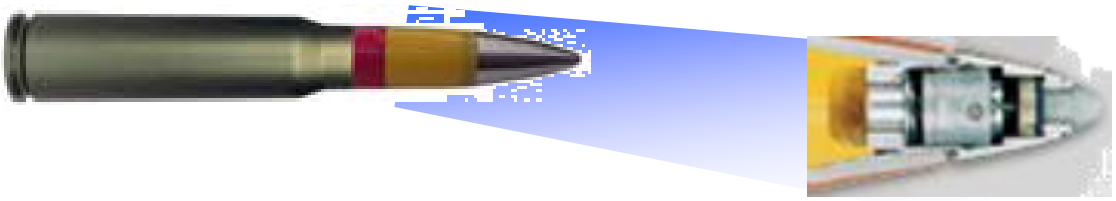
- 5” guided projectile development is not currently funded

Additional Navy Gun Ammunition

- 57mm MK 295 Mod 0 – High Explosive – 3P Cartridge (HE-3P)
  - Pre-fragmented explosive projectile with programmable, proximity fuze
  - 6 Fuze Modes:
    - Time Gated Proximity (TGP), Time Gated Prox with Impact Priority (TGIP), Point Detonating (PD), Point Detonating Delay (PD/D), Electronic Time (ET), Proximity with Self Destruct



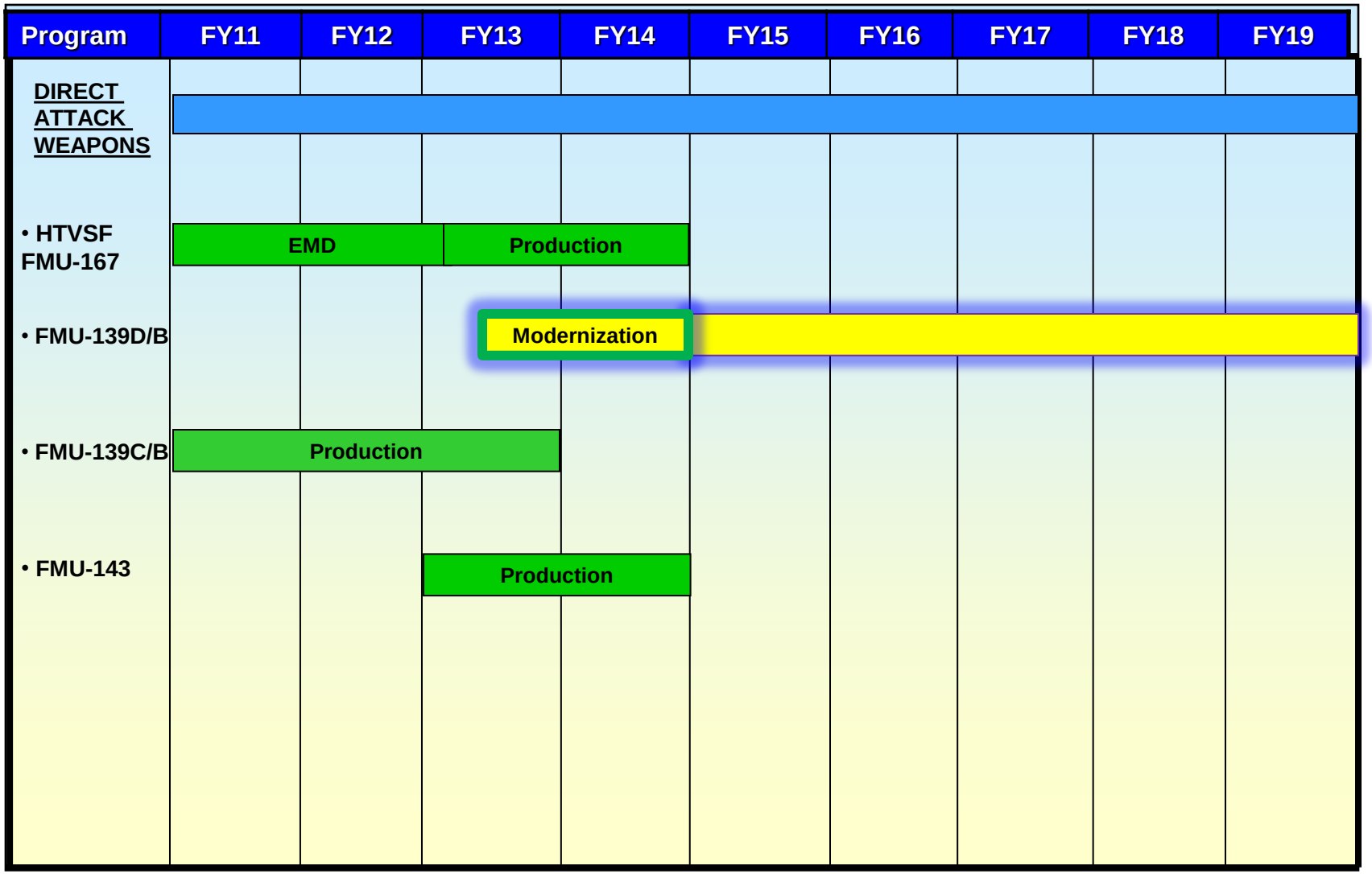
- 30mm X 173 MK266 Mod 1 – High Explosive Incendiary – Traced (HEI-T)
  - Super Quick FMU-151 Fuzed PBXN-5 projectile
  - High Order Blast/Fragmentation w/ Incendiary Effects



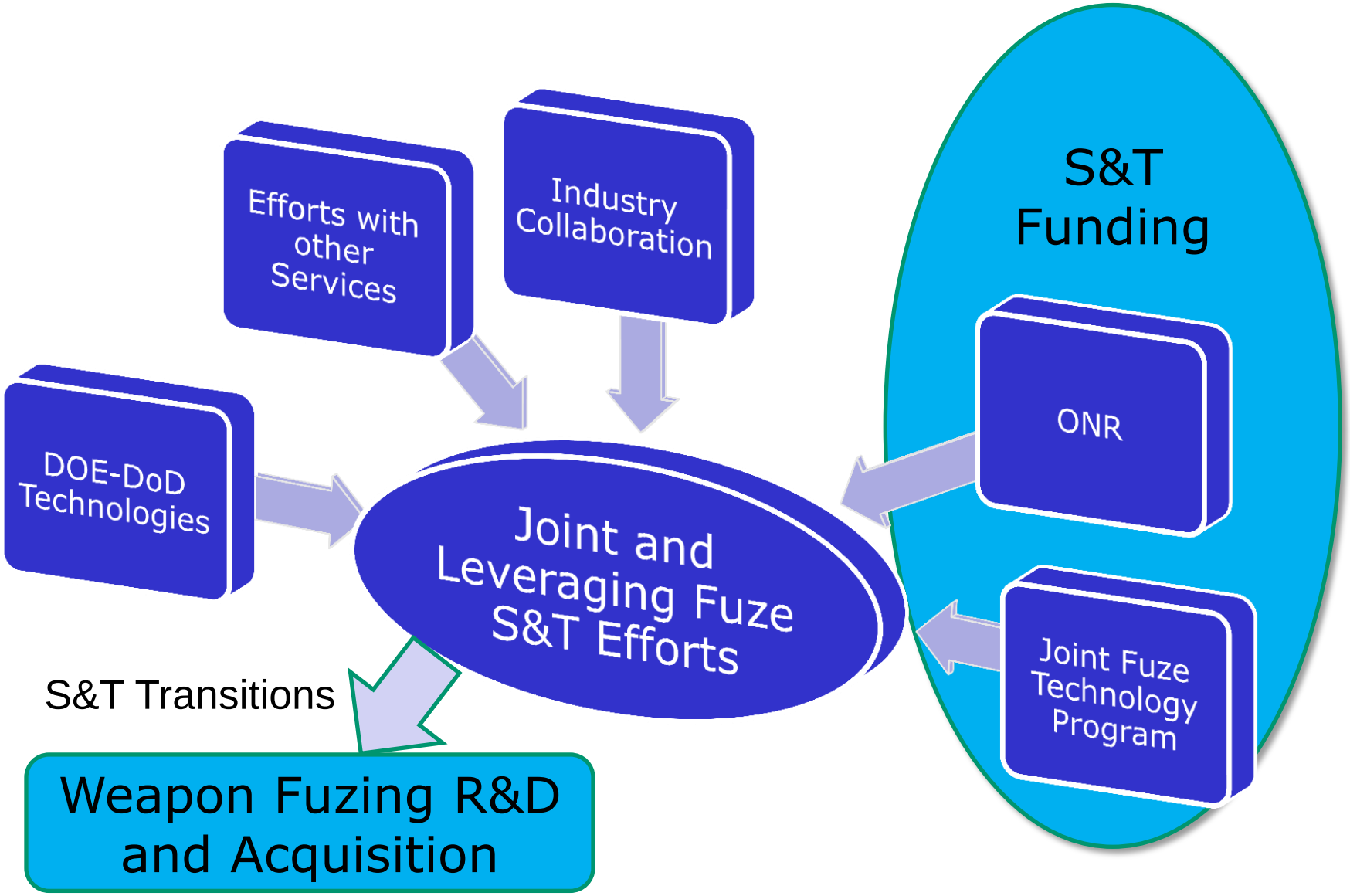
PMA-201 Fuze Procurement Strategies

- **Cost effective approaches for enhancing current fuzes**
  - **Leverage spiral development of existing fuzes**
  - **Refurbish/recondition existing inventories**
  - **Modify existing inventories to meet new requirements**
  - **Incremental demonstration/integration of new technologies**
- **Service life extension programs for existing fuze inventories**
  - **Increase Ordnance Assessment (OA) activities**
  - **Conduct Ordnance Health Assessment program**

PMA-201 Fuze Roadmap



Navy Fuze Technology

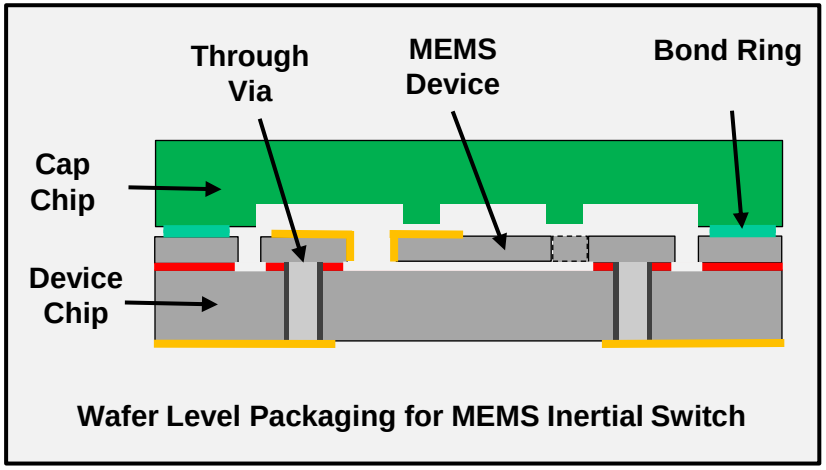


Navy Fuze S&T Work Highlights

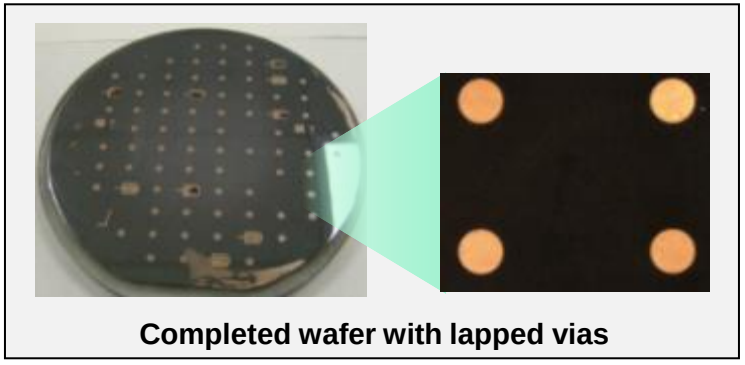
- **ONR: MEMS Fuze for Marine Corp Flight Control Mortar**
- **Joint Fuze Technology Program - Navy Projects Briefed at Conference:**
  - **Enhanced Performance of MEMS Electric Initiators**
  - **Wafer Level Packaging for High Aspect Ratio MEMS**
  - **Retard/Impact Sensor**
- **Joint Fuze Technology Program – Additional Navy Projects & Involvement:**
  - **Bellows Motor**
  - **Advance Proximity Sensing**
  - **Hard Target Survivability – Modeling & Simulation, Testing, Encapsulation, Materials**

Wafer Level Packaging for High Aspect Ratio MEMS

- Develop wafer level packaging techniques that are applicable to high-aspect ratio MEMS devices
  - Wafer bonding
  - Through vias
- Improved reliability and safety of MEMS components in the fuze, including sensors and / or the MEMS S&A chip
- Increased throughput (2 orders of magnitude) and yield of the MEMS manufacturing process
- Lower cost S&A (high volume weapon applications)



Wafer Level Packaging for MEMS Inertial Switch

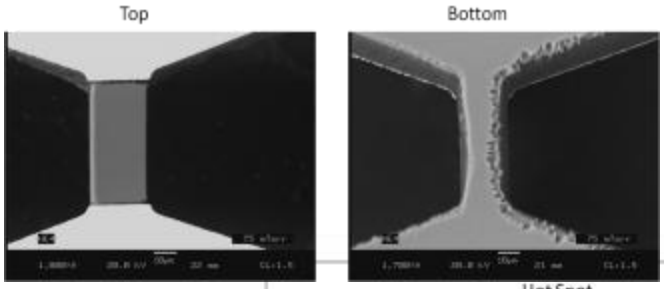

Completed wafer with lapped vias

Open Session VA briefing provided by Kevin Cochran

Enhanced Performance of MEMS Electric Initiators

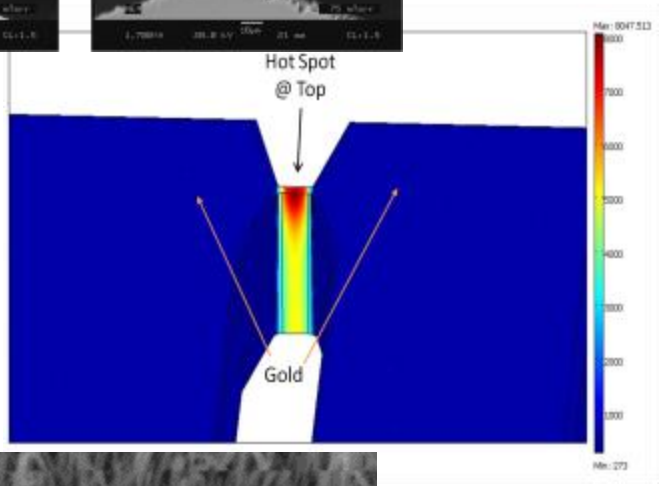
- Increase the output of an initiator that can be easily integrated into a MEMS fuze to maximize micro-detonator output
  - Replaces low performance energetic
  - Prompt initiation (< 2µs)
  - Low power (< 1mJ)
  - Highly uniform fabrication
- Understand differences between reactive material bridge as compared to simple metal/silicon
- Provides compact, safe and low energy S&A for distributed multipoint initiation systems

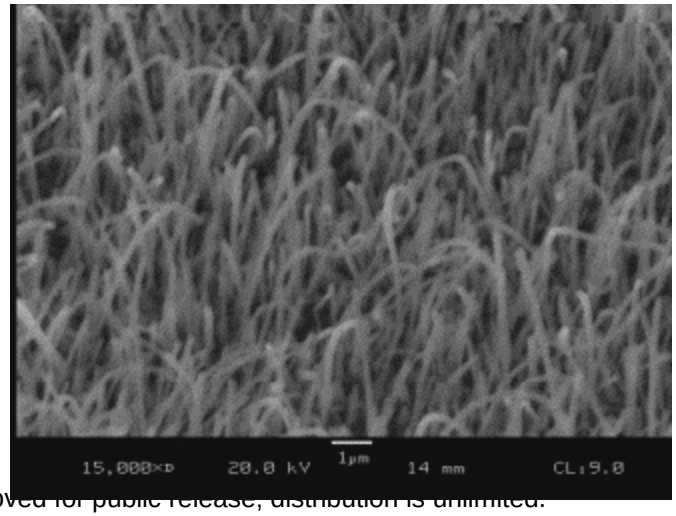
Closed Session IVB briefing provided by Dan Pines



DRIE of Si Bridge

Model Hot Spots



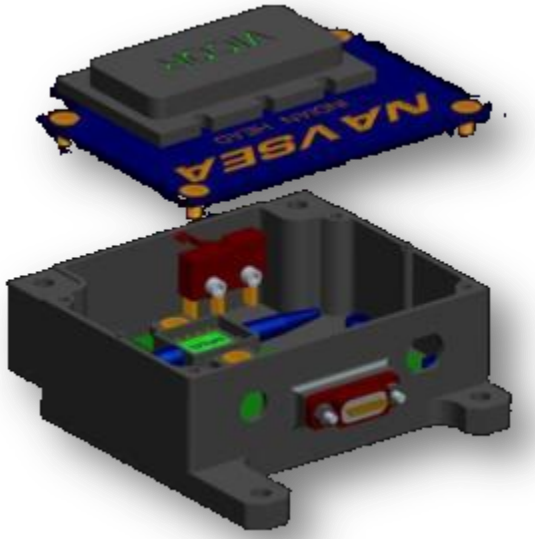


RM Nanowires

MEMS Optical Ignition Switch for THAAD

- Develop and evaluate a high reliability MEMS optical alignment switch for direct optical ignition systems
  - Rugged, reliability system in the form of hermetic MEMS package
  - Cost effective approach proven through batch processing
  - High power transfer (1-5W)

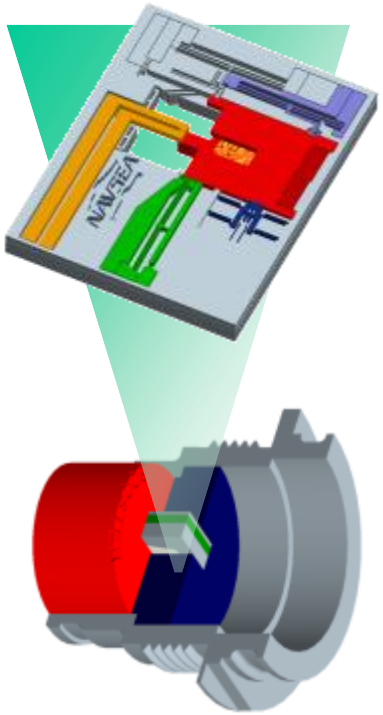
Closed Session IIIB briefing provided by Alex Cox

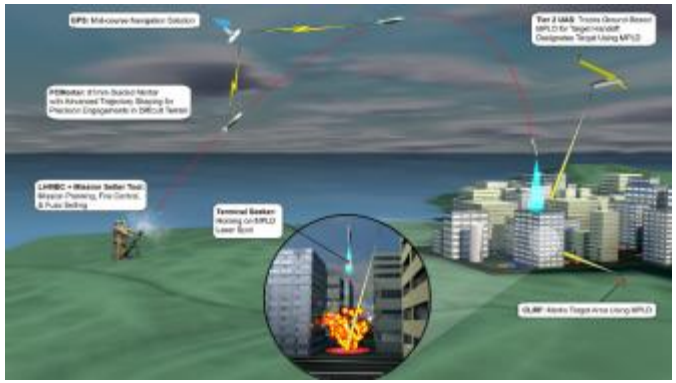


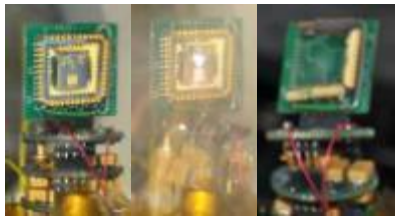
Concept → Prototype

Navy MEMS Fuze For Marine Corp Flight Control Mortar

- MEMS based S&A for 81 mm Precision Urban Mortar Attack (**PUMA**) – ONR Future Naval Capability (FNC)
  - Joint Navy / Army S&T system development
  - Supports Marine Corps Conventional Weapons (CW) Science & Technology Objectives
  - System demonstration in FY14







Closed Session IIIB briefing provided by Dan Jean

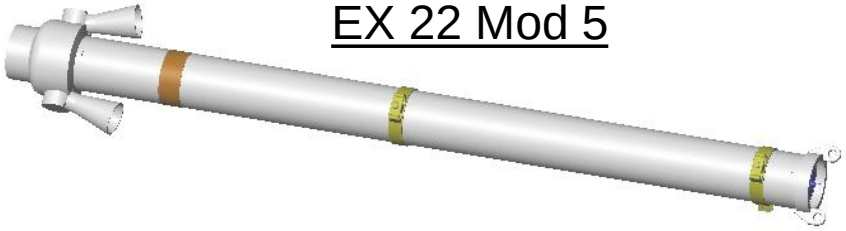
Active Mitigation: Rocket Initiator Thermally Activated (RITA) IM Device for the MK22

- Develop active blast mitigation for MK22 Rocket Motor for use in confined spaces
  - Fully vent both ends using a thermally activated shape memory alloy (NiTiNOL) release mechanisms
  - Ignite surface of propellant prior to auto-ignition using an Active Mitigation Device (AMD)
  - No degradation of IM characteristics and performance

Open Session IIIB briefing provided by Matthew Sanford

SAFE and Fire Mechanism using NiTiNOL

EX 22 Mod 5



MEMS Retard & Impact Sensors

Closed Session IIIB briefing provided by Walt Maurer

- ***Bomb Fuze Retard and Impact Sensors***

- ***Traditional coil spring-mass technology:***
  - *Wide performance variability per mechanical spring tolerances*
  - *Difficult to precisely sense low G's with "macro world" springs*

- ***MEMS technology appears well-suited for making improved low-G sensors per DoD exploratory work to date:***
  - *NAWCWD: precision-electroplated G-sensors*
  - *NSWCIH: silicon G-sensors and packaging*
  - *ARDEC: metal G-sensors and packaging*

Illustration and Photograph Courtesy of NAWCWD

- ***Focus: low-G impact sensors (<100G) & very low-G retard sensors (<5G)***

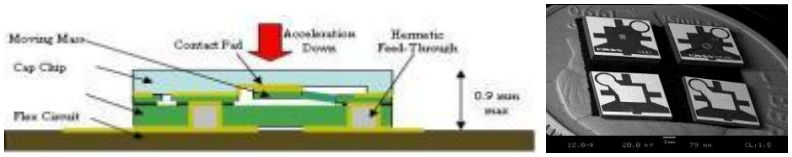


Illustration and Photograph Courtesy of NSWCIHDIV

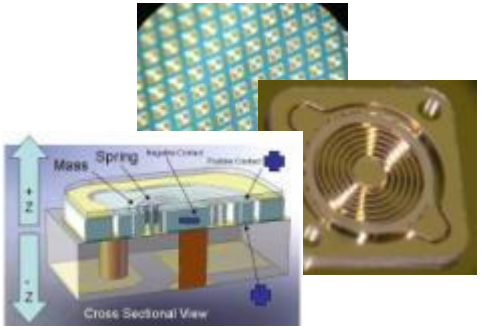
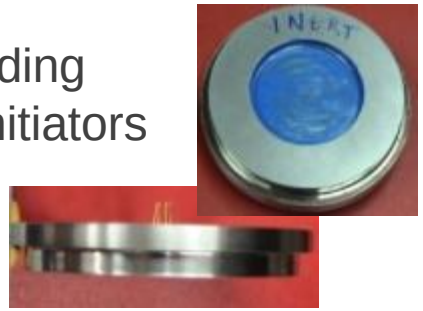


Illustration and Photographs Courtesy of ARDEC

Advanced Initiation Technologies for Weapon Systems in 22 Century

- Enabling the safe and reliable initiation of Extremely Insensitive Energetics

Exploding Foil Initiators

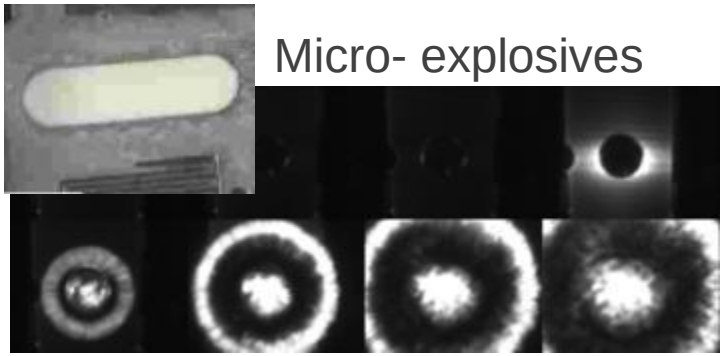


Digital Detonator

New Energetic Materials

Closed Session IVB provided by Aubrey Farmer

- Reducing the volume and power requirements for initiation systems



Micro- explosives

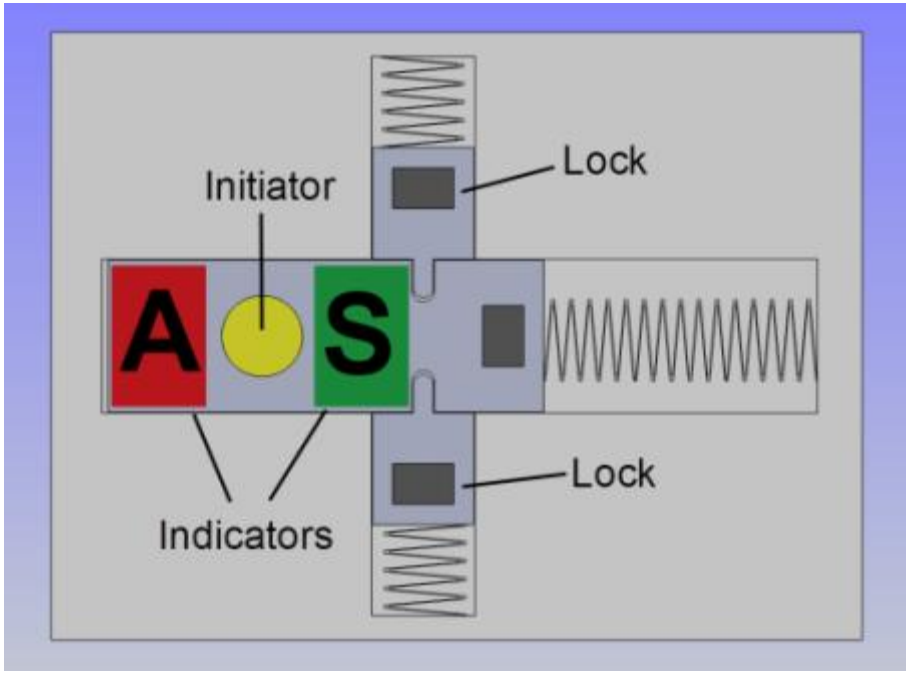
(MEMS)

HYDRA

An Electromechanical S&A Suitable for Specialized Miniature Munitions

- Low-Voltage, Out-of-Line Safe & Arm Device
- Remote Monitoring System
  - Allows the User to Know the Status of the Weapon (Armed or Safe)
- Micro-Machined Mechanical Parts Allow for Miniature Size
- Can be Commanded to Return to a Safe Mode

Closed Session
IVB provided by
Deric Mason



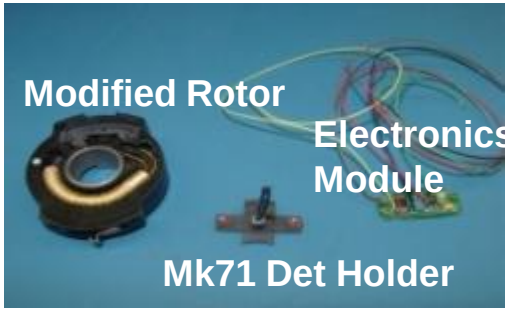
Variable Energy Research Accelerator (VERA)

- Unique gun built, for fuze testing.
  - Live or inert projectiles up to 200 lbm
  - Low acceleration forces (<600 Gs typical)
  - Useful velocities (Mach 0.5 – Mach 1.5)
  - Low cost construction & operation
  - Large bore (19 inch)
- ***Attained IOC in fall, 2011***

Open Session VA briefing provided by David Hall

Hardened FMU-139 Fuze Demonstration

OBJECTIVE: Modify FMU-139 bomb fuze design to survive BLU-109 warhead penetration environment and initiate warhead 120ms after impact
APPROACH: Embed an electronic time delay and firing circuit module in fuze's Safe & Arm Rotor Assembly
RESULTS: Fuze survived the penetration event in BLU-109 and detonated its booster at the preset delay of 120 ms (Actual Measured Delay of 121ms) after target impact



Modified Rotor Components (Pre-Potted)


Fuze Assembly

Closed Session VB briefing provided by Alan Derkey

Questions