Naval Air Systems Command Fuzing Overview

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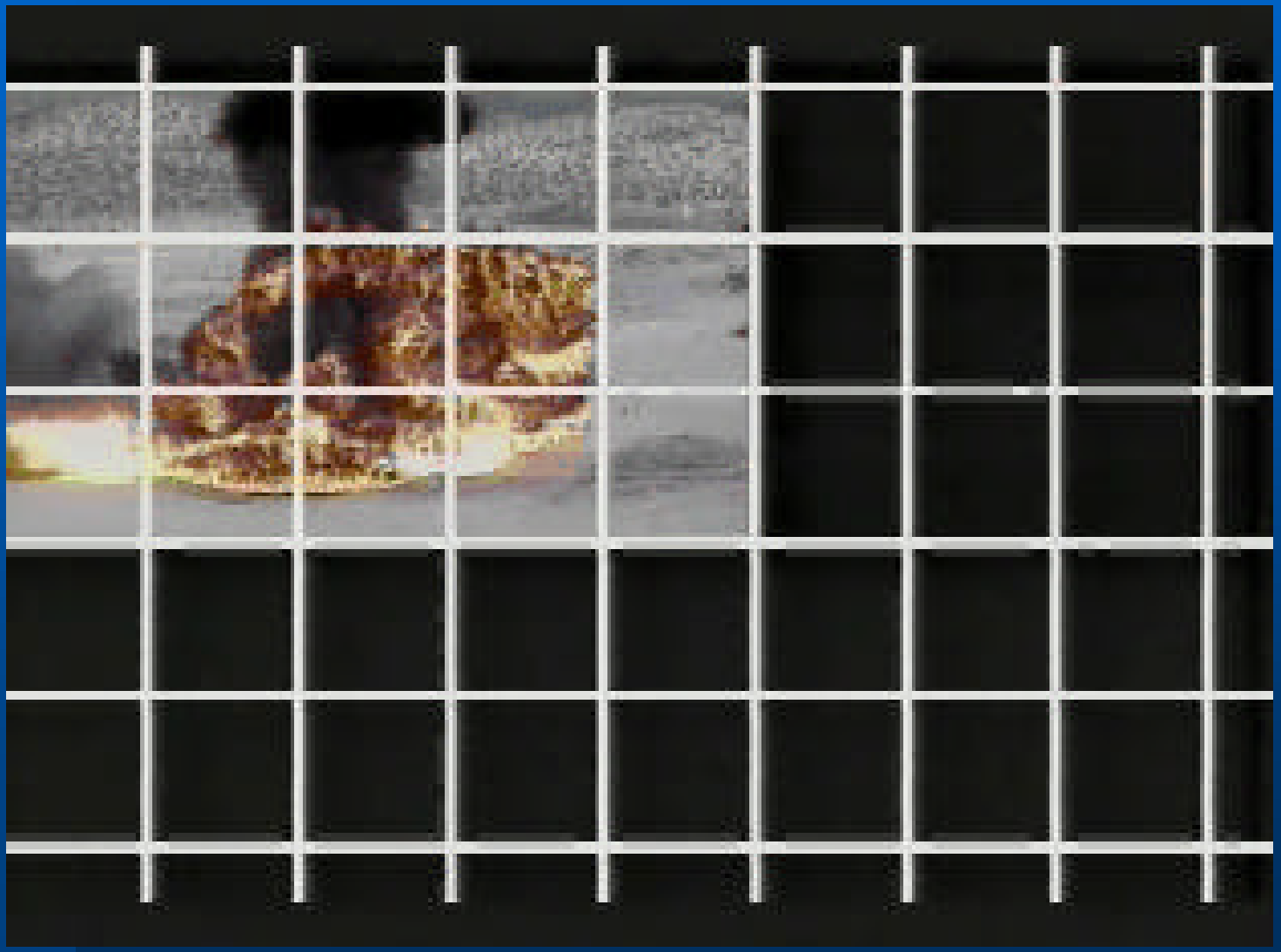
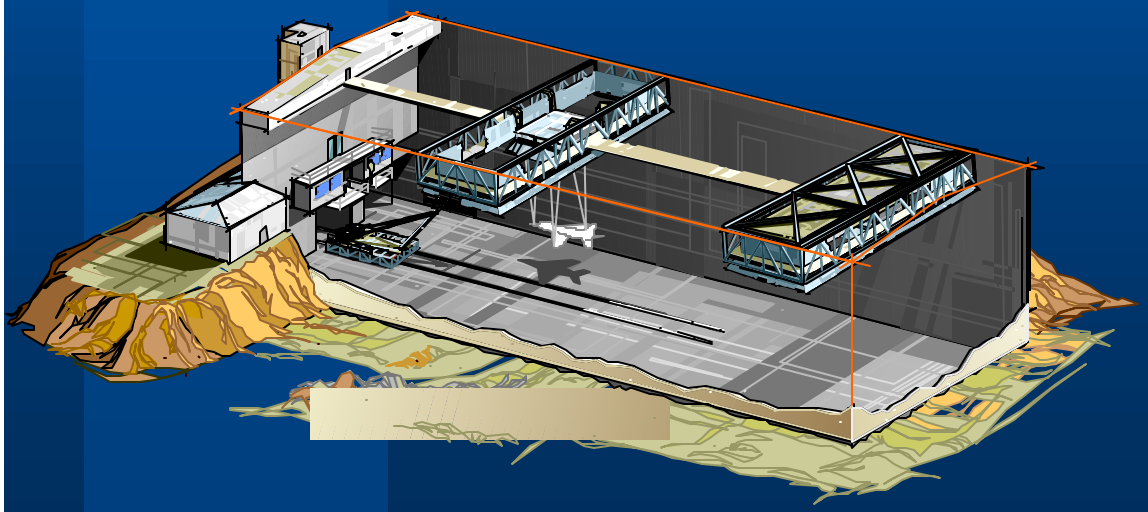
Naval Air Warfare Center Weapons Division

A Full-Spectrum Capability



Missile Engagement Simulation Arena



- **Products and Services**
  - **Fuze**
    - **Testing and evaluation**
    - **Consultation on design and testing methodologies**
  - **Diverse Testing operations**
  - **TDD Foreign Military Exploitation**
  - **Field test consultation**
  - **Portable radar signature/ antenna testing**

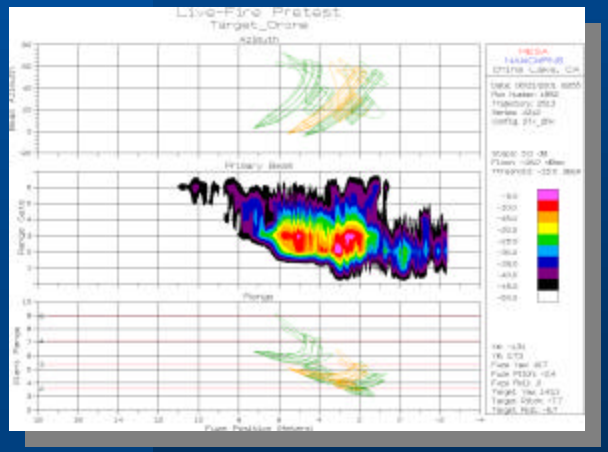
Length = 405 Ft
Width = 150 Ft
Height = 90 Ft

MESA Testing of Full-Scale Aircraft

F-4 Fighter

Fuze Testing Against F-18

Mig-23 Fighter



Example of Fuze Data Results

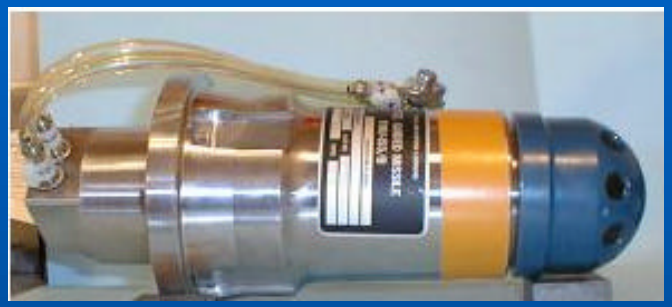
- Guidance and Fuze Testing
  - Fuze Design and Development
  - Fuze optimization
  - Platform survivability
  - Terminal guidance investigation

Fuze Systems

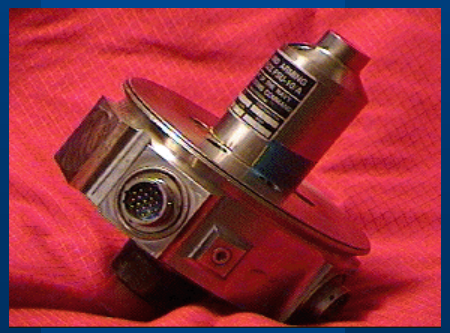
Missile S-A Devices

HARM MISSILE FUZE, FMU-111/B

TOMAHAWK BLK 3 FUZE, FMU-148/B

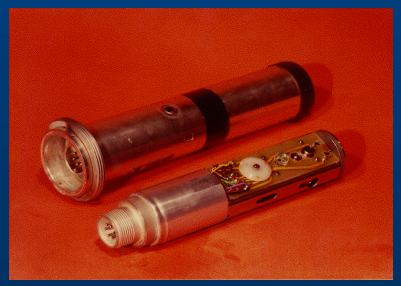


SLAM ER, FMU-155/B



PHOENIX MISSILE FUZE, FSU-10/A

SPARROW MISSILE S-A, MK-33

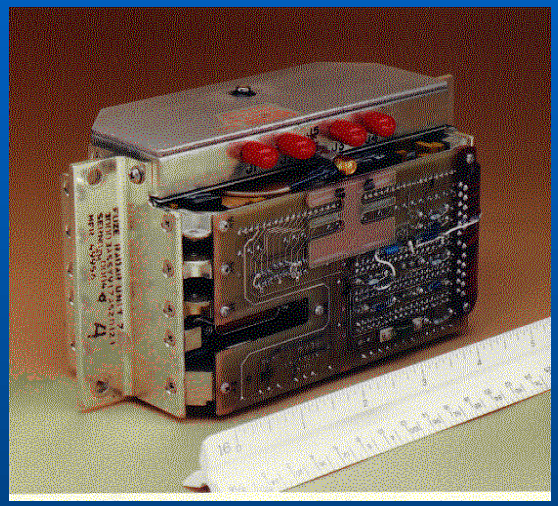


SIDEWINDER MISSILE FUZE, MK-13 MOD 2

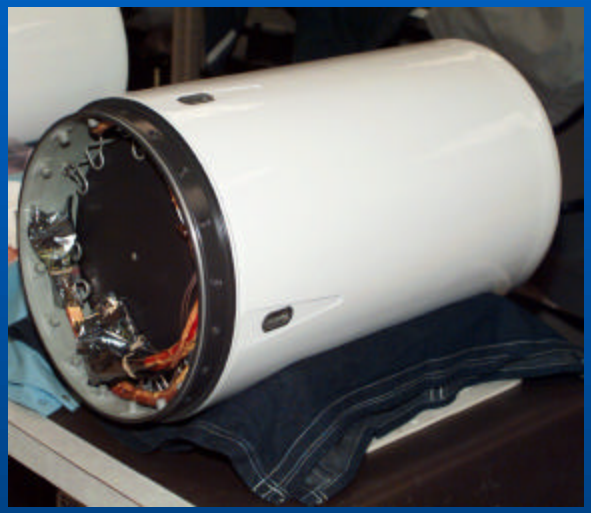
STANDARD MISSILE S-A, MK 54 MOD 0

Missile Target Detecting Devices

RAM
MK-20 AOTD



SEA SPARROW/ESSM
DSU-34 TDD



Standard Missile
MK-45 TDD

Free-Fall Weapon Fuzes

FMU-139 A/B, Electronic Bomb Fuze

DSU-33B/B Proximity Sensor

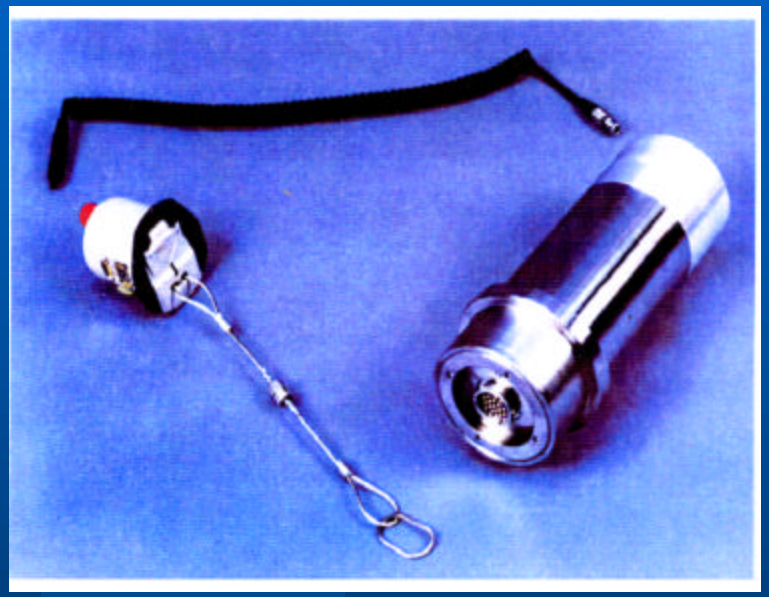
FMU-143, Electronic Bomb Fuze

FMU-140 /B, Dispenser Proximity Fuze

FMU-139 Rebooster Program

- FMU-139, joint in-service, general-purpose fuze
- The FMU-139B/B is a retrofit to the current FMU-139A/B fuzes
- Improvements include:
  - Replacement of CH-6 booster pellets with PBXN-7
  - The addition of two (2) transvoltage suppressors
  - Replacement of explosive leads with new leads
  - Elimination of the MK-3 Arming Wire
- Production startup January 2000
- 200,000 FMU-139B/B fuzes completed by the end of FY 01

Support for Joint Fuzes



FMU-159
Hard Target Smart Fuze

FMU-152
Joint Programmable Fuze (JPF)

Fuze Technology Programs

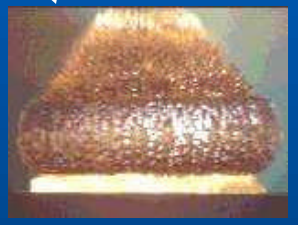
Low Energy EFI Technology

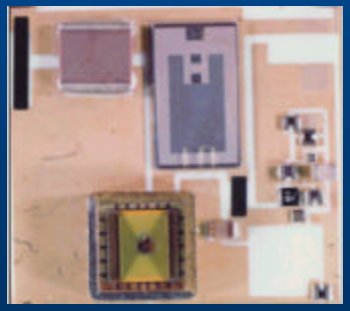
- State Of The Art
  - Low Energy Exploding Foil Initiators
  - Alternative Explosive Materials
  - Increase Energy Output
- Benefits
  - Significant Cost Savings to the Navy
  - Significant Performance Enhancements

Low Energy EFI Detonator
- Fully Qualified
- Manufactured by Silicon Designs and Reynolds Systems

EFI Firing a Booster

Booster Detonating

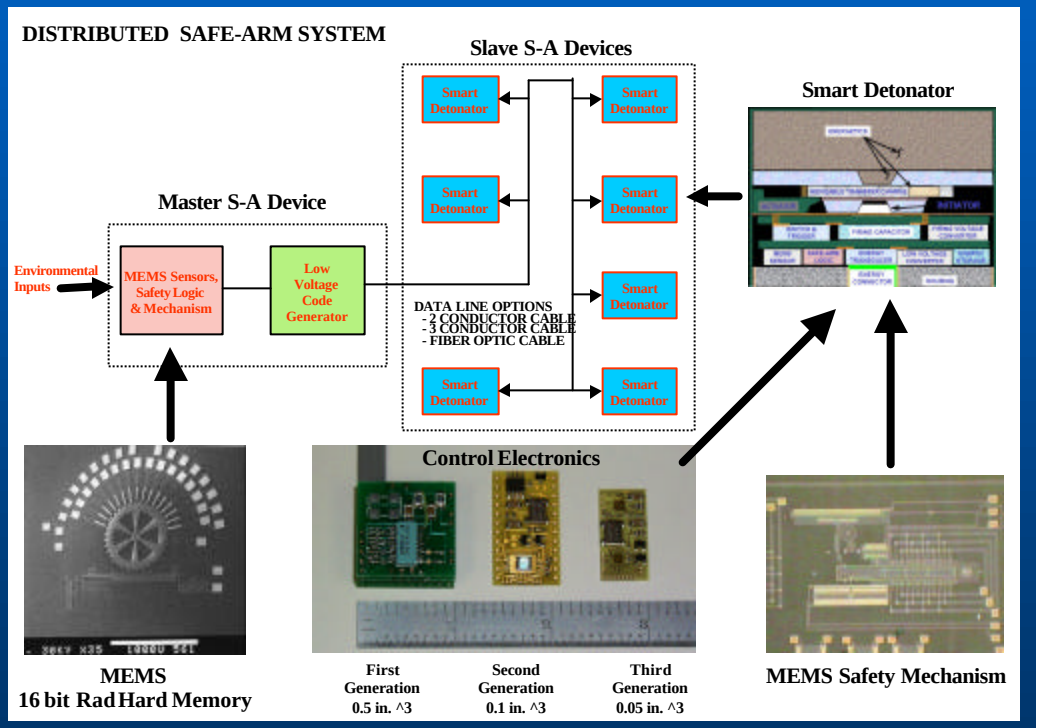




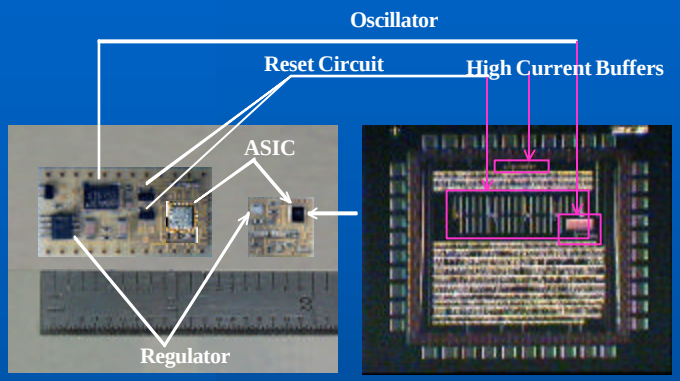
Integrated EFI with Solid State Fire Set

MEMS-Based Distributed S-A

- **Description:**
  - Master control unit senses arming environments per MIL-STD-1316, then generates unique arming commands to selected "slave" detonators
  - Each det contains MEMS mechanical locks to prevent inadvertent arming
  - Up to "n" dets distributed within system to enhance performance
- **Major Accomplishments:**
  - Safety analysis of arming commands
  - Shown MEMS ability to move loads
  - Proven basic in-line, out-of-line safety
  - Shown transfer of small charges
  - Significant size reduction of electronics
- **Future Plans:**
  - Complete design
  - Demonstrate Feasibility
  - Integrate Electronics/MEMS/Explosives

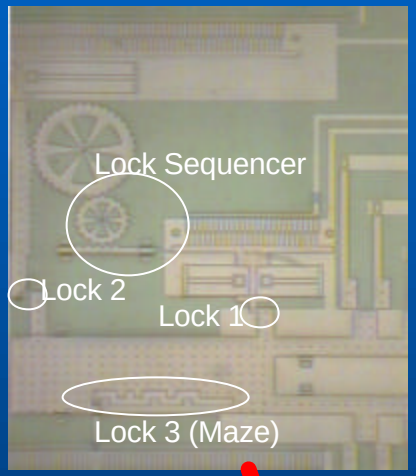


Enabling Fuze Technology

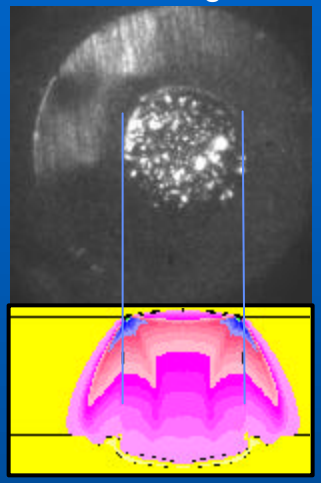


Miniature Electronics and Mix Signal ASIC

MEMS Safety Mechanism



Modeling



Hydrocode prediction and test results

MEMS Sensors

Electronic Safety Logic

Micro-Detonator & Explosive Train

Optional

Weapon Data

Arming Environments

Master Control Unit

Sub Controller

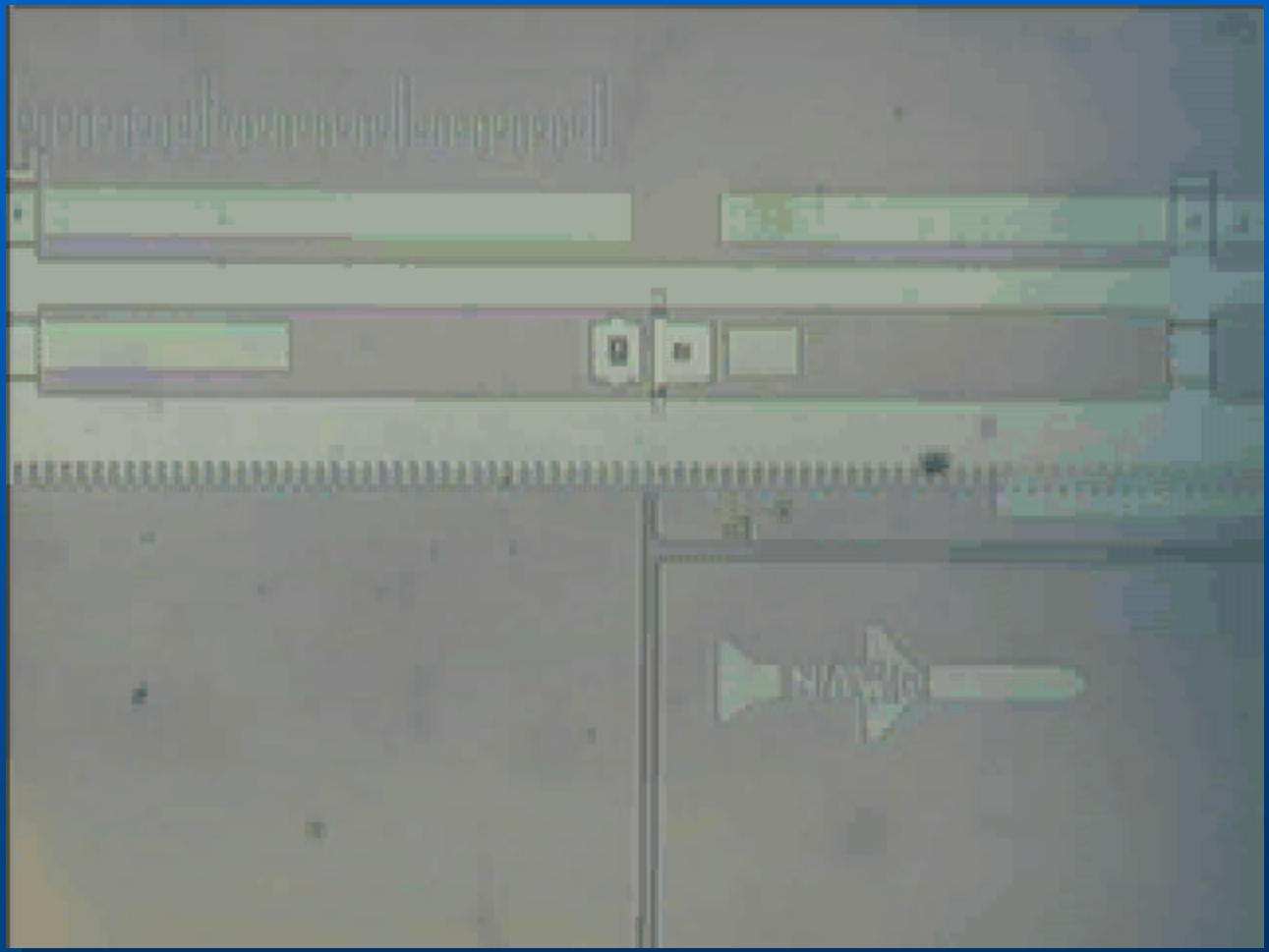
Munition Arm-Fire Device (Smart Det)

Munition Arm-Fire Device (Smart Det)

Munition Arm-Fire Device (Smart Det)

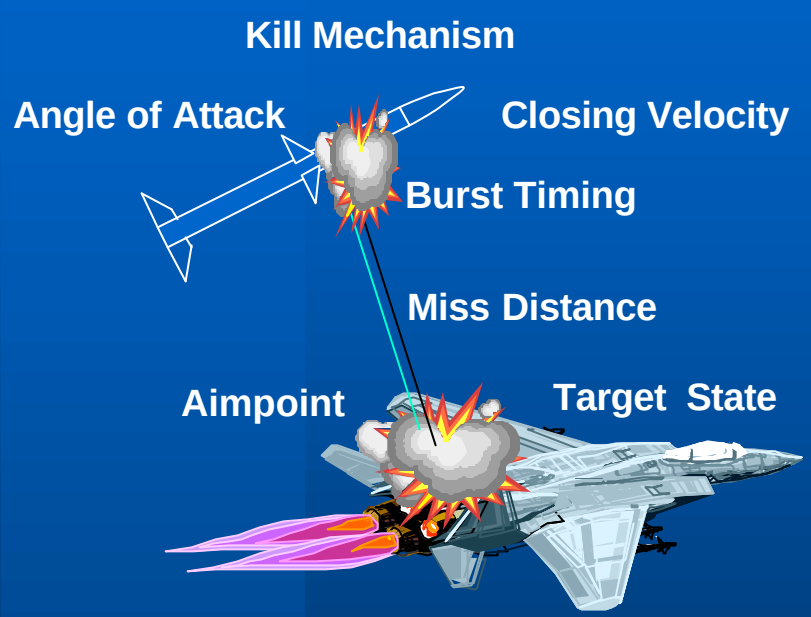
Fuzing System

MEMS Based Distributed S-A (cont'd)



Computer controlled rack driver

Precision Intercept



What Are We Trying To Do

- Develop methods to produce missile management algorithms that maximize missile lethality
- Manage intercept conditions for optimal lethality using:
  - Target state information from missile sensors and network centric warfare grid
  - Missile endgame trajectory and attitude w.r.t. target orientation
  - Warhead mode options
  - Knowledge of target-warhead vulnerability space

What Makes it Possible

- High resolution forward-looking endgame sensors
  - Reduce measurements errors
  - Target extent and orientation information
- Taking advantage of synergies between warhead/target information and missile dynamics
- Modern processors can support higher processing loads

What Difference Will it Make

- Greater Pk over wider encounter conditions & spectrum of target types
- Offers reduced weapon size / weight by providing same lethality with smaller warhead

Short Pulse Laser TDD

- **Objective**
  - Provide High Endgame Lethality For SBD Against Sea Skimming Supersonic Maneuvering Targets In Benign and Adverse Environmental Conditions
  - Extend the Operational Capability of Fuzing Subsystems to Include:
    - All Aspect Encounter
    - Adverse Weather
    - Increased Target Sets
    - Low Altitude Severe Clutter Operation
  - Demonstrate operation in adverse weather to Support Warhead Lethal Range
  - Apply Advanced Sensor and Receiver Technology to Low Altitude SBD Problem

- **Approach**
  - First Order Analysis Shows Good "All Weather" Capability
    - Short Pulse Laser Sensor
      - Discriminates Against Aerosols and Clutter
      - Target Profiling
  - High Peak Power Narrow Pulse Laser Transmitters Offer:
    - Small Size and Volume
    - Large Target to Aerosol Backscatter Ratio
  - High Bandwidth / High Gain Receivers Offer:
    - Increased Signal to Noise Ratio
    - Increased BW & Sensitivity for Short Pulses

- **Payoff**
  - Increased Pk Against SBD Targets
    - Adverse Environmental Conditions
      - Aerosol
      - Sea Clutter
    - All Aspect Encounter

SEAD Fuze

Objectives:

- **Direct target detection design**
- **Establish low probability of false alarm in clutter with a high probability of target detection**
- **Fuze cost compatible with missile platform**

Approach:

- Exploit MMW target/clutter discriminants using radar (amplitude, phase, polarization, etc.) and radiometric data
- Mature the target/clutter discrimination technologies through analysis, simulation, and critical experiments with a measurement sensor.

Payoff:

- **Improved Pk through direct target measurements**
  - **Independent of Terminal Approach**

Lessons Learned:

- Strike TDD requirement driver is false alarm rate on clutter
- Target/clutter discrimination based on return amplitude alone is not reliable
- Target/clutter discrimination demonstrated with polarization, phase, and radiometric methods
- Phase processing is least expensive
- Radiometry is lowest risk

Summary

- Navy Lead for Missile and Free-Fall Weapons Fuzing

Supporting

➡ Technology

➡ Development

➡ Production

➡ In-Service