

# Fuzing & Firing Systems at Sandia National Laboratories

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Lake Buena Vista, Florida

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.



# Sandia's Four Mission Areas

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Lake Buena Vista, FL

May 19-21, 2009

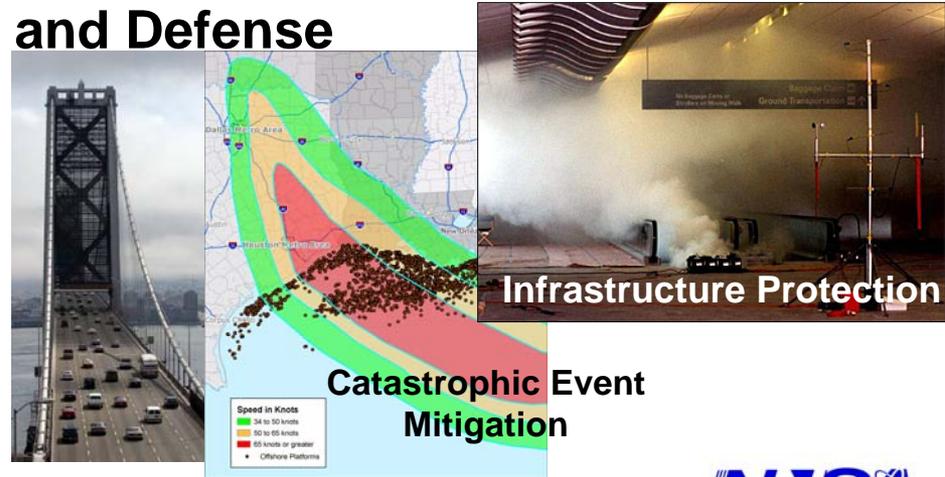
## Nuclear Weapons

## Defense Systems and Assessments



## Energy, Resources, and Nonproliferation

## Homeland Security and Defense



# Evolution of Sandia's Advanced Fuzing/Firing Systems Technologies

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- **Focus on Design and Weaponization**

- **Mission: design, engineer, integrate, test, and provide production interface, for all non-nuclear components of a nuclear weapon**



B83  
Total Parts=6519

- |                   |                      |                   |
|-------------------|----------------------|-------------------|
| • Radar Fuzes     | • Switches           | • Batteries       |
| • Impact Fuzes    | • Switch Tubes       | • Timers          |
| • Firing Sets     | • Rectifiers         | • Spin Generators |
| • Shock Absorbers | • Programmers        | • Parachutes      |
| • Casing          | • Neutron Generators | • Ejector Systems |
| • Detonators      | • Reservoirs         | • PAL Controllers |
| • Capacitors      | • Stronglinks        | • Explosives      |

- **Maintain deep foundation of science and engineering in our technical competencies**

**to position the nation to evaluate and respond to developments in the international environment or to developments in the weapons technology of other nations**



B61-11 Nuclear Earth Penetrator



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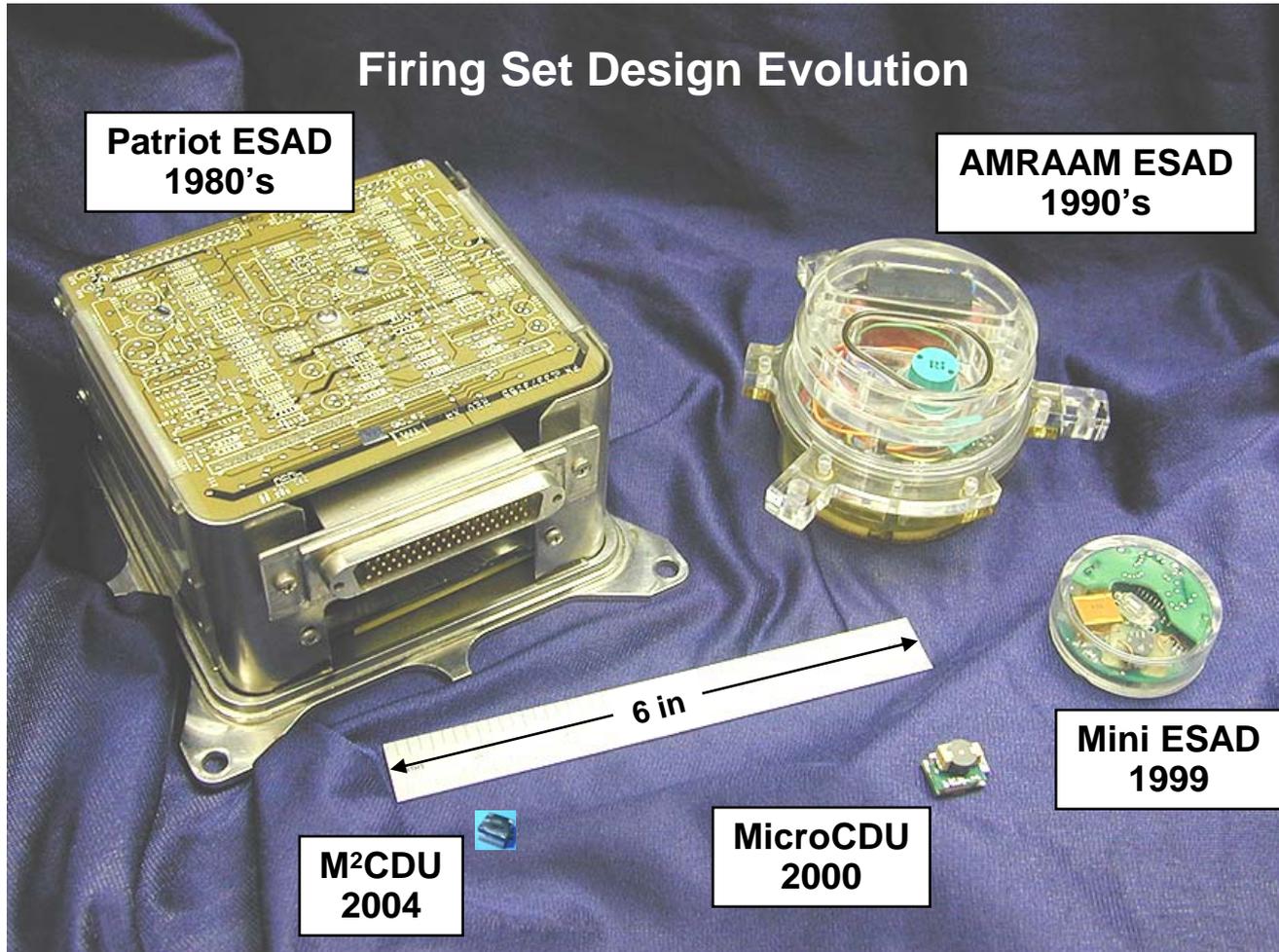


# Evolution of Sandia ESAD Fuze Technology

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# SNL Fuzing/Firing Systems Investment Areas

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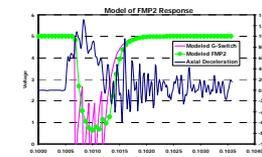
- **Fuze Technology Development**

- Advance the fuze technology and component development to support the requirements of our new national challenges
- Explore strategies to survive new environments through miniaturization, integration, and robust packaging



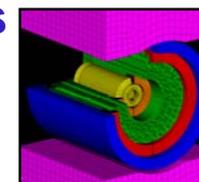
- **Penetration Environment Characterization**

- Need to better understand the Hard Target penetration environment and fuze component environment



- **Modeling and Simulation**

- Need the ability to model and predict environments seen by firing systems as penetrating warheads impact hard targets



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# Fuze Technology Development

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## Miniature Electronic In-Line Fuze Modules

Meet safety theme MIL-STD 1316E and MILSTD1901A



FMP2 Hardened Firing Set

## Monolithic MicroCDU (M<sup>2</sup>CDU)

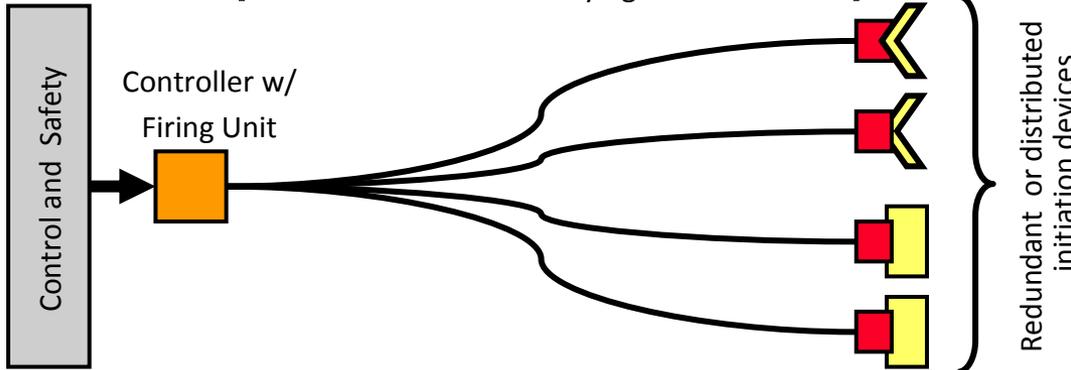
Rugged, Miniature, In-Line CDU for ESAD



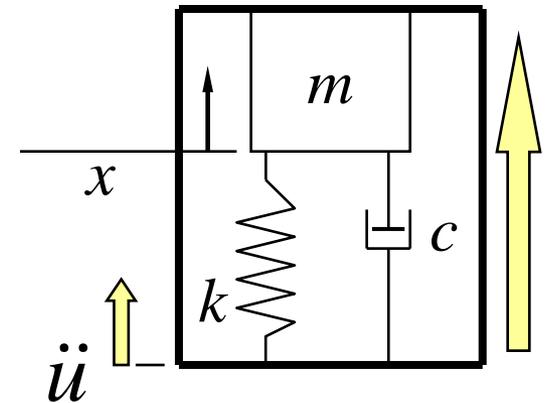
0.36" x 0.40" x 0.20" (T)

## Multipoint Initiation and Selectable Firing

← Low-Current Carrying Wires →



## Modeling of Sensor Response for Target Detection Improvements



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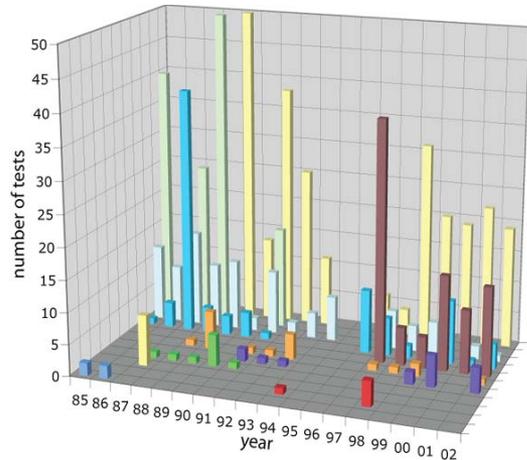


# Penetration Environment Characterization

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- Air gun/cable for NASA Comet
- Air drop from balloon
- Army 155mm gun into walls
- NW rocket into earth & water
- NW rocket sled into earth & walls
- B61 Cable pull into concrete
- Powder gun into concrete & earth
- B61 air drop into earth, water & ice
- NW Davis gun into earth & rock
- NSWC air gun into water & ice
- NW Gas gun into earth, rock & ice



## High-G Instrumentation

**MinPen ('97)**  
3 Axis Recorder

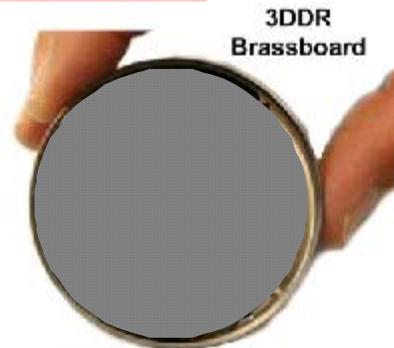


**3AMP ('02)**  
3 Axis Recorder



**MilliPen ('99)**  
Single Axis Recorder

**3DDR ('09)**  
3 Axis DTRA  
Data Recorder



3DDR  
Brassboard

Test Article Pre-Test



Test Article Post-Test



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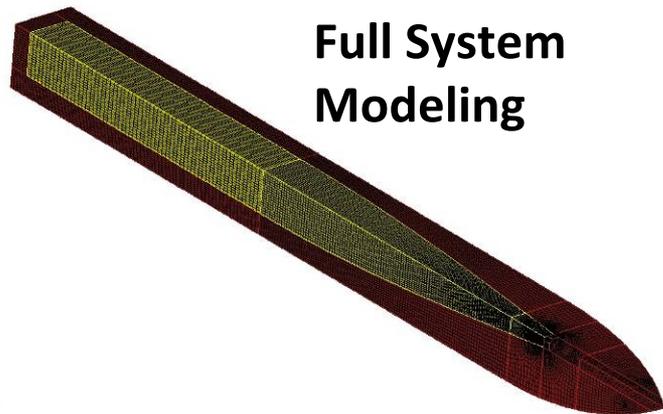


# Modeling and Simulation

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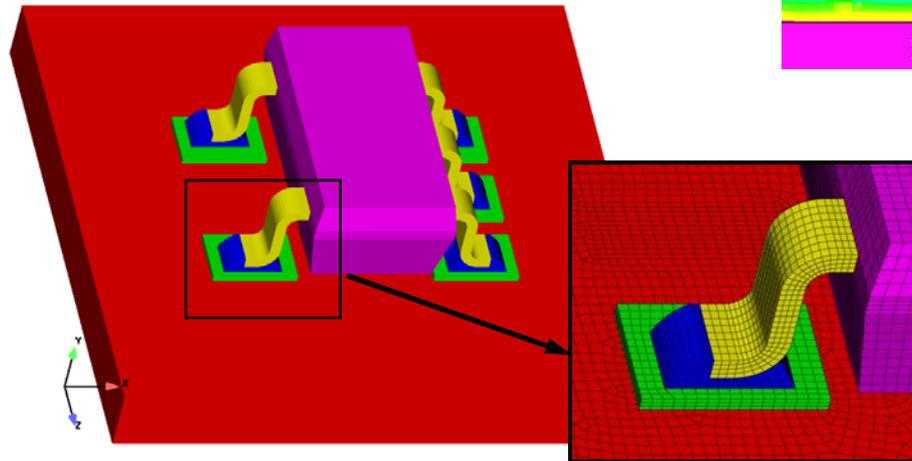
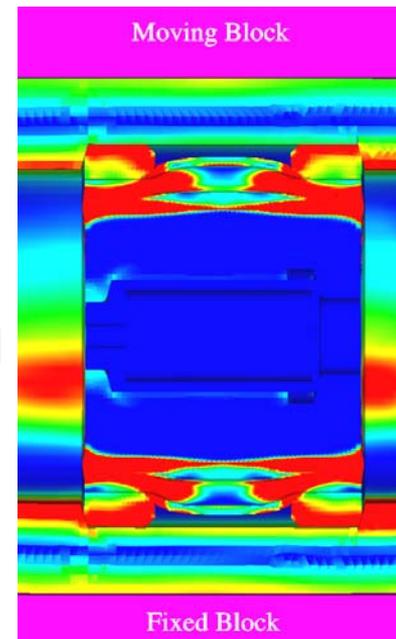
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**Full System Modeling**

**Weapon Component Level Modeling**



**Modeling of individual circuit components**



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# Fuze Technology Investment Partners

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## DTRA



Hard Target Fuzing and Instrumentation Research

## DOE

Nuclear Weapons Advanced Development



## DoD/DOE Joint Munitions Program

Weapons research in Areas of joint interest



## Army - AMRDEC

Hardened selectable output warheads



## Air Force - AFRL

Collaborative teaming for hard target defeat



## Sandia Laboratory Directed Research and Development (LDRD)

High Speed Hard Target Warhead Development

## Navy - SP

High speed Hard target defeat



## CRADA Partners



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# DOE Firing Systems for Nuclear Weapons

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Lawrence Livermore

Develop Main Detonators



**DOE Weapon Firing System**



Sandia



Develop Firing Set

- Capacitive Discharge Based
- Optically Based

**Sandia works with Los Alamos and Lawrence Livermore National Laboratories to develop Firing and Initiation Systems for Nuclear Weapons**



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# Unclassified Unlimited Release Joint DoD/DOE Munitions Program (JMP) DoD-DOE Memorandum of Understanding

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MEMORANDUM OF UNDERSTANDING  
BETWEEN  
THE DEPARTMENT OF DEFENSE  
AND  
THE DEPARTMENT OF ENERGY  
FOR THE CONDUCT OF A COOPERATIVE  
RESEARCH AND DEVELOPMENT PROGRAM

I. PURPOSE: The purpose of this Memorandum of Understanding (MOU) is to establish an arrangement between the Department of Defense (DoD) and the Department of Energy (DOE) for the conduct of a cooperative program of research and development intended to bring about major improvements in nonnuclear munitions technology (NNMT).

II. BACKGROUND: The DoD and the DOE regard the improvement of NNMT as a task of high national importance. The nuclear weapons design and

F. Termination: This agreement may be terminated at any time by mutual agreement between the DoD and the DOE, or upon six months written notification by either the DoD or the DOE. Funding for work in progress when a unilateral termination notice is received will continue until the end of the budget year in which the termination becomes effective. Final reports will be prepared and circulated for all work in progress at the time of the termination notice or agreement; the cost of preparing and distributing such final reports will be covered by the remaining cooperative program funds. No new work is to be started under this MOU after the termination agreement or receipt of the unilateral termination notice.

G. Effective Date: This memorandum of understanding is effective when signed by both parties.

DEPARTMENT OF ENERGY

DEPARTMENT OF DEFENSE

By William V. Hoover  
Assistant Secretary  
for Defense Programs

By James P. Wade, Jr.  
Acting Under Secretary  
of Defense Research  
and Engineering

Date December 21, 1984

Date Feb 5, 1985

- MOU signed by DoD/DDR&E and DOE/DP in 1985
- Goal: explore and develop technologies intended to bring about major improvements in non-nuclear munitions benefitting both Depts.
- Jointly funded by DoD and DOE-Labs
- Focus and adapt the DOE nuclear weapons technology-base to enable major advances in DoD warfighting capabilities
- Support long-term R&D at the 3 DOE NW labs with DoD & DOE oversight
- Cooperative, jointly-funded efforts in:
  - Initiation, Fuzing, & Sensors
  - Energetic Materials
  - Computational Mechanics & Material Modeling
  - Warhead Technologies
  - Munitions Lifecycle
- Requires a balance between DoD and DOE priorities
- Participation is government only; technologies transitioned thru DOTC and lab mechanisms



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Unclassified Unlimited Release

# JMP Technology Coordinating Groups (TCGs)

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- I Computational Mechanics & Material Modeling**
- II Lethality Enhancement & Effectiveness**
- III Energetic Materials**
- IV Warheads & Integration Technology**
- IX Munitions Lifecycle**
- X Firing Systems**
- XI Penetration Technology**
- XIII Sensors**
- XIV Predictive Materials Aging & Reliability**



# Joint Munitions Program & Fuzing/Firing Systems Projects

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- Los Alamos, Lawrence Livermore, and Sandia National Labs have active R&D projects in this area
- Technologies such as Exploding Foil Initiators, Monolithic Micro Capacitive Discharge Units (M<sup>2</sup>CDU), and Low-Temperature Co-fired Ceramic (LTCC) Transformers have been developed and transitioned
- Once technologies are sufficiently mature, they are offered for transition to industry through the Defense Ordnance Technology Consortium (DOTC) (<http://www.nwec-dotc.org/>) and laboratory mechanisms
- DOTC development programs are opportunities to reduce new technology risk and achieve production readiness



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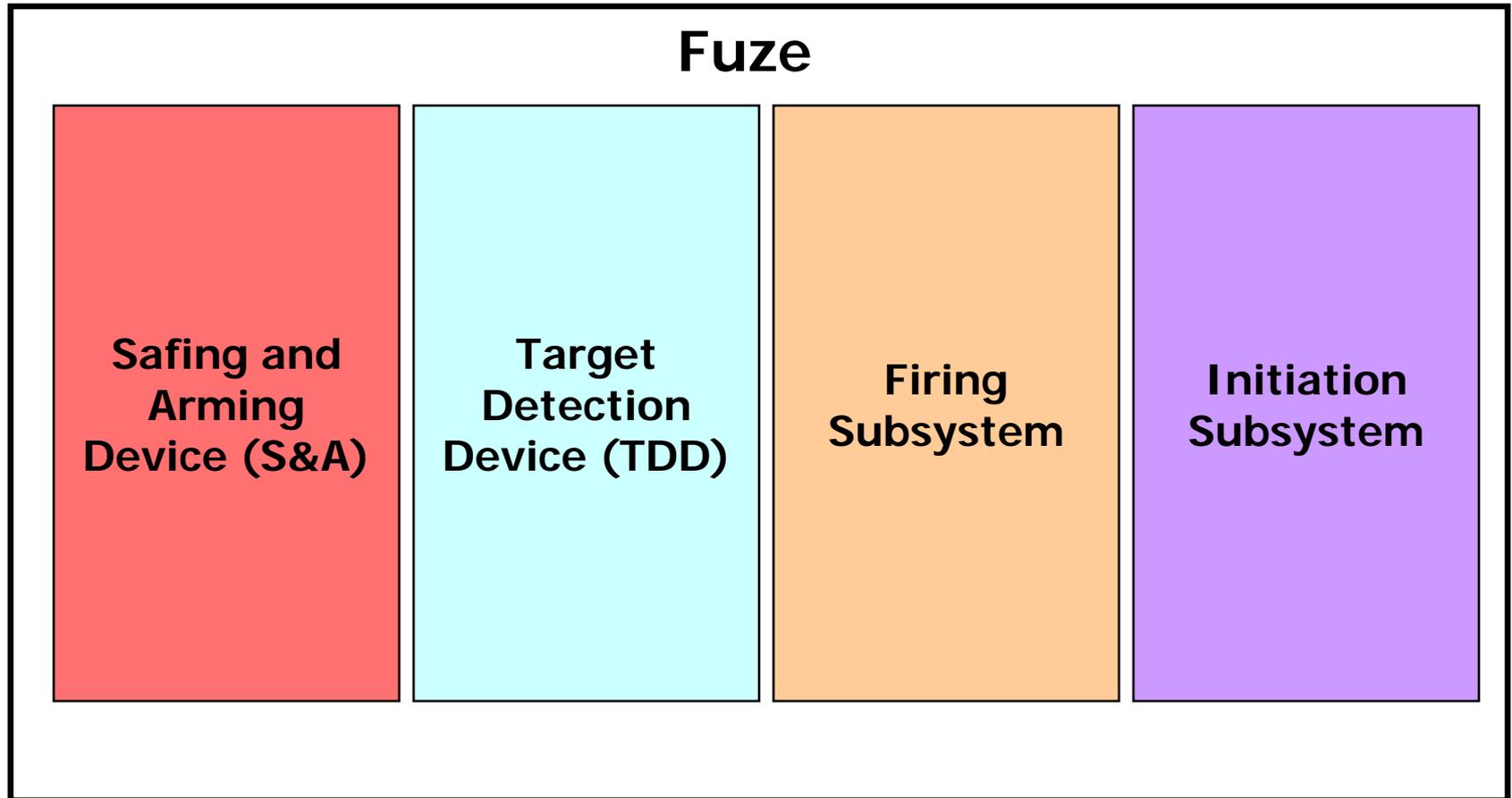
# What is a Fuze?

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## Simplified Fuzing Functions



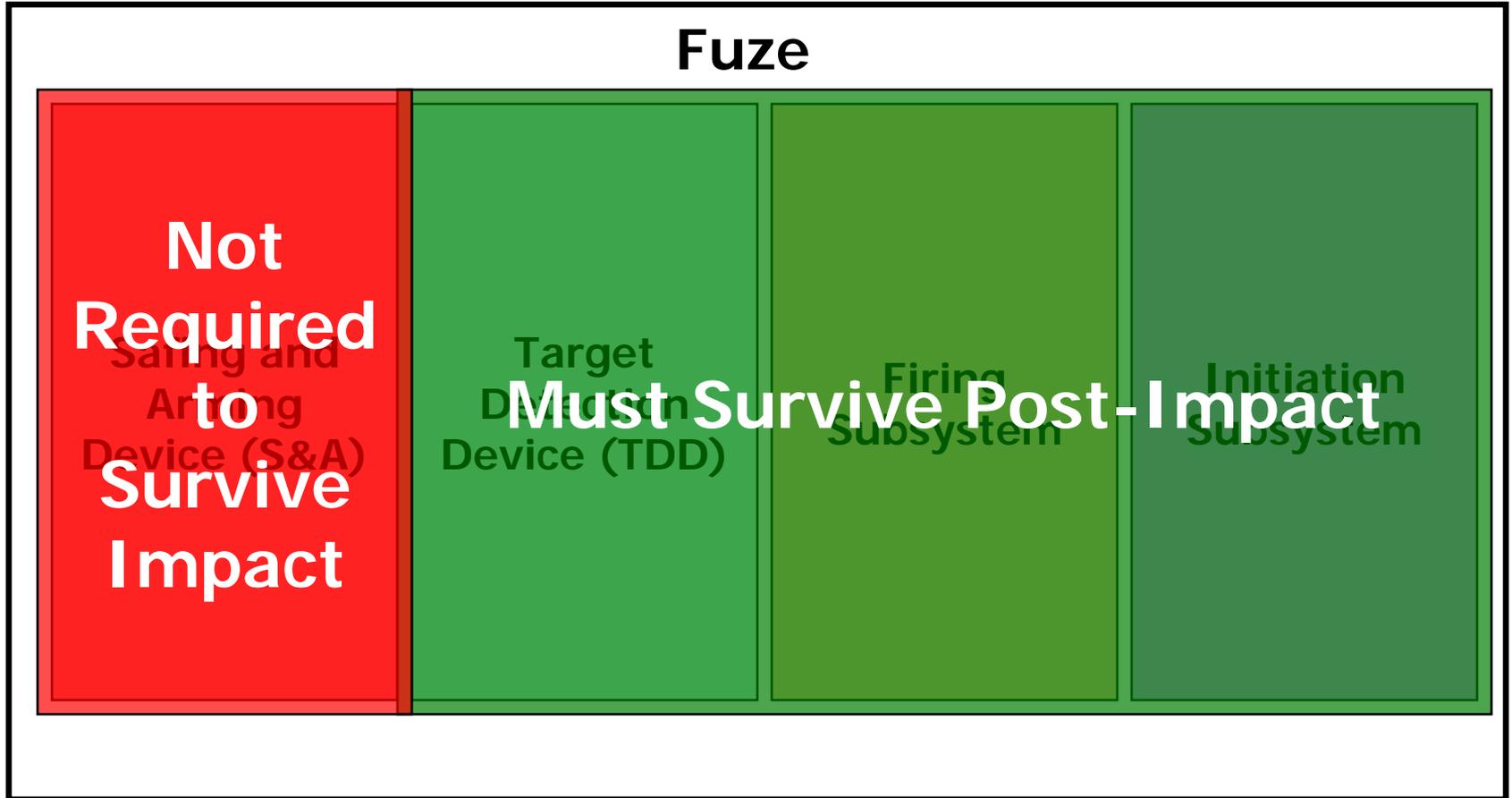
# What is a Fuze?

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## Simplified Fuzing Functions (As applied to Post Impact Survival Fuzing)



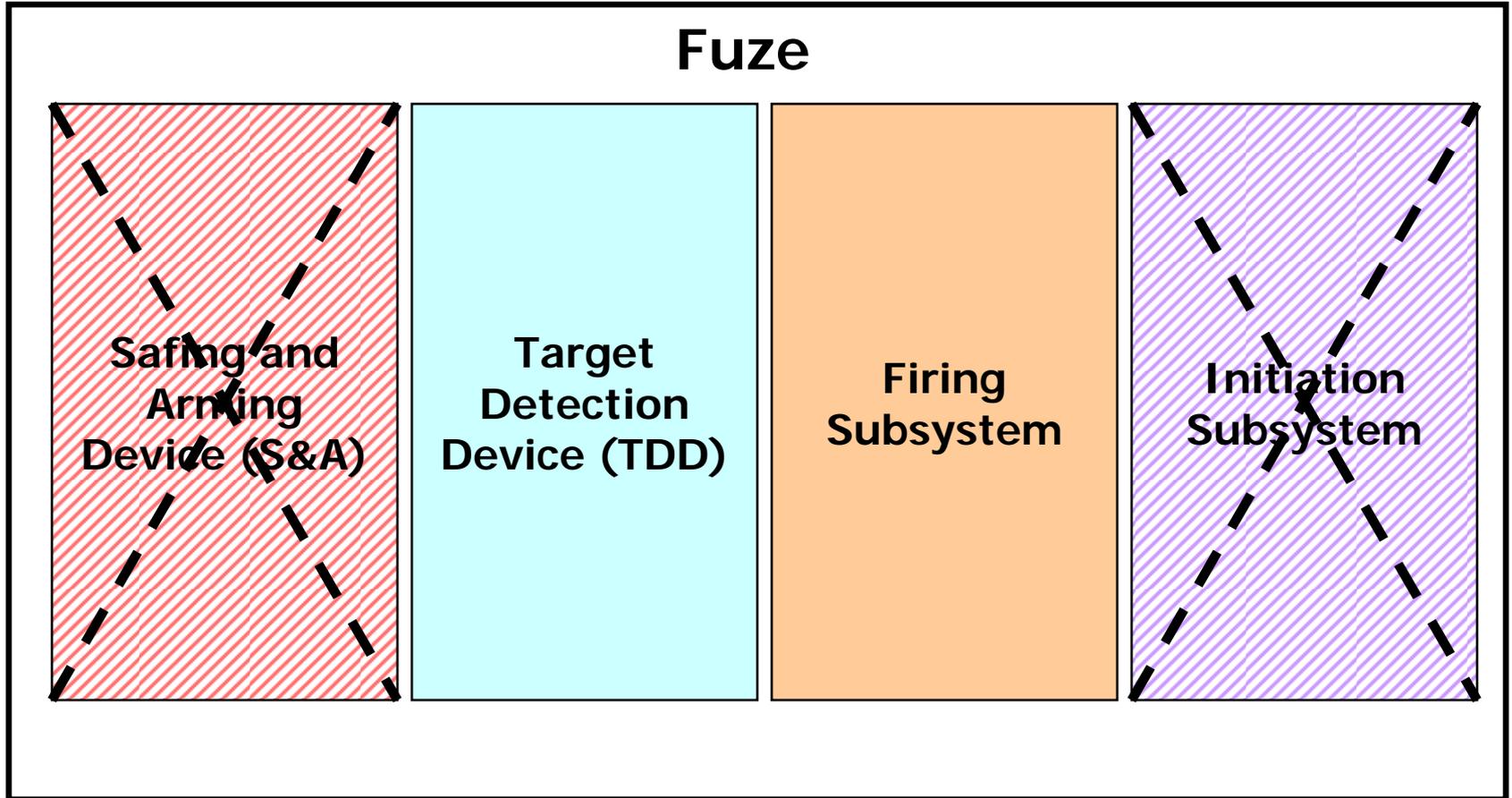
# DTRA Funded Fuze Diagnostic Recorder (FDR)

## Focus Areas

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# DTRA Fuze and Instrumentation Technology Fuze Diagnostic Recorder (FDR) Program



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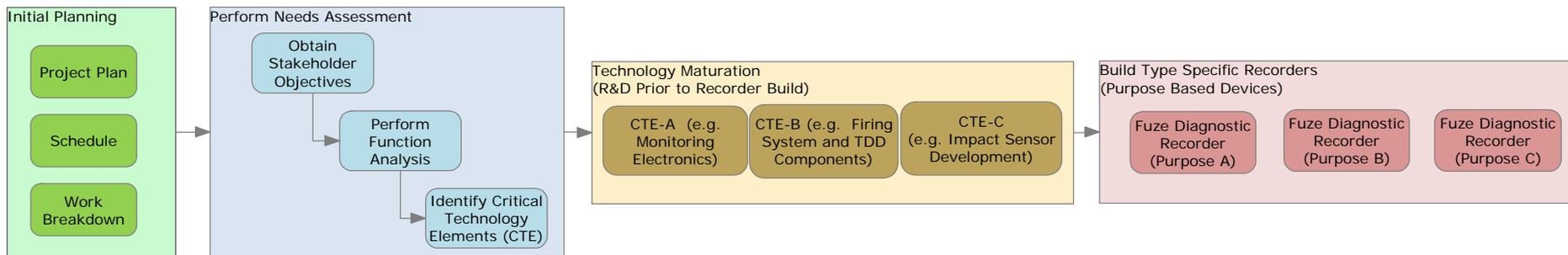
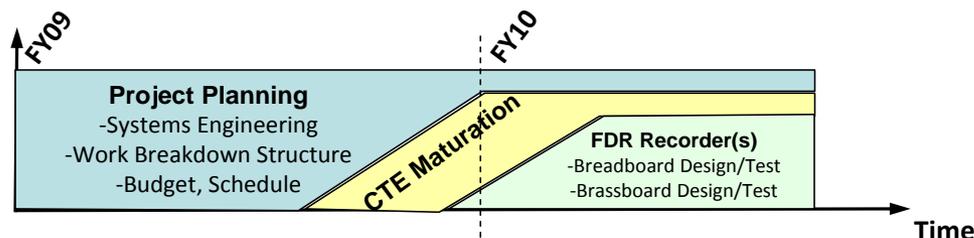
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## PROJECT GOAL:

- Improve electronic hard target fuzes by monitoring and recording post-impact critical functions in harsh impact environments.

## RESEARCH OBJECTIVES:

1. Improve understanding of weaknesses and failures in electronic firing systems exposed to hard target environments.
2. Develop methodologies for data collection of post-impact critical components to enable objective #1.
3. Improve impact detection and target sensing by monitoring a suite of inertial impact sensors.



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# End of Presentation

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## Questions?

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