# New Solutions for S&A and Firing Functions in Modern Fuzes

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**57th NDIA Fuze Conference - July 29-31, 2014**

***"Collaboration for Fuzing Challenges"***

**Newark, NJ**

**Max Perrin**

A Diehl and Thales Company

# Outline

- **Fuze and S&A Devices – Requirements evolution**
- **New Needs – New Functionalities**
- **Technical solutions**
- **Focus on new solutions for:**
  - Electro-mechanical S&A Devices
  - Electronic S&A Devices

# JUNGHANS – The Fuze Company

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**A leader in the field of ammunition fuzes and S&A Devices for missiles and munitions**

**Complete range of fuzes for all types of munitions**

**Key competences in Fuzing technologies, Micro-technologies and Ammunition electronics**

# Main Types of SAD

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| | *Current use* | *New trend* |
|---|---|---|
| **Mechanical SAD** | All type of munitions and missile | Mainly tube launched munitions |
| **Electromechanical SAD** | Missile and aerial bombs, some munitions | All type of munitions, small missiles |
| **Electronic SAD** | High value missile | Aerial bombs, small missiles, smart munitions |

# New Requirements directly impacting the Fuze and SAD Evolution

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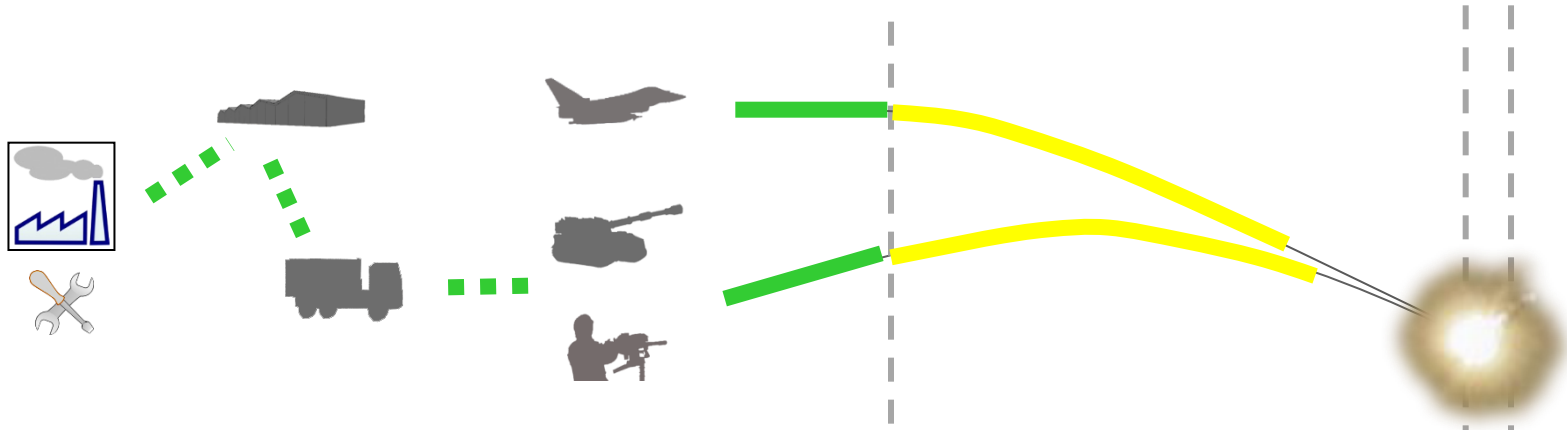

Better Operational Flexibility Multi-modes / Mode Selection

Terminal Effect Improvement + Collateral Damage Reduction

Conventional Safety Requirements

New Safety Requirements

# New Requirements – New Trends

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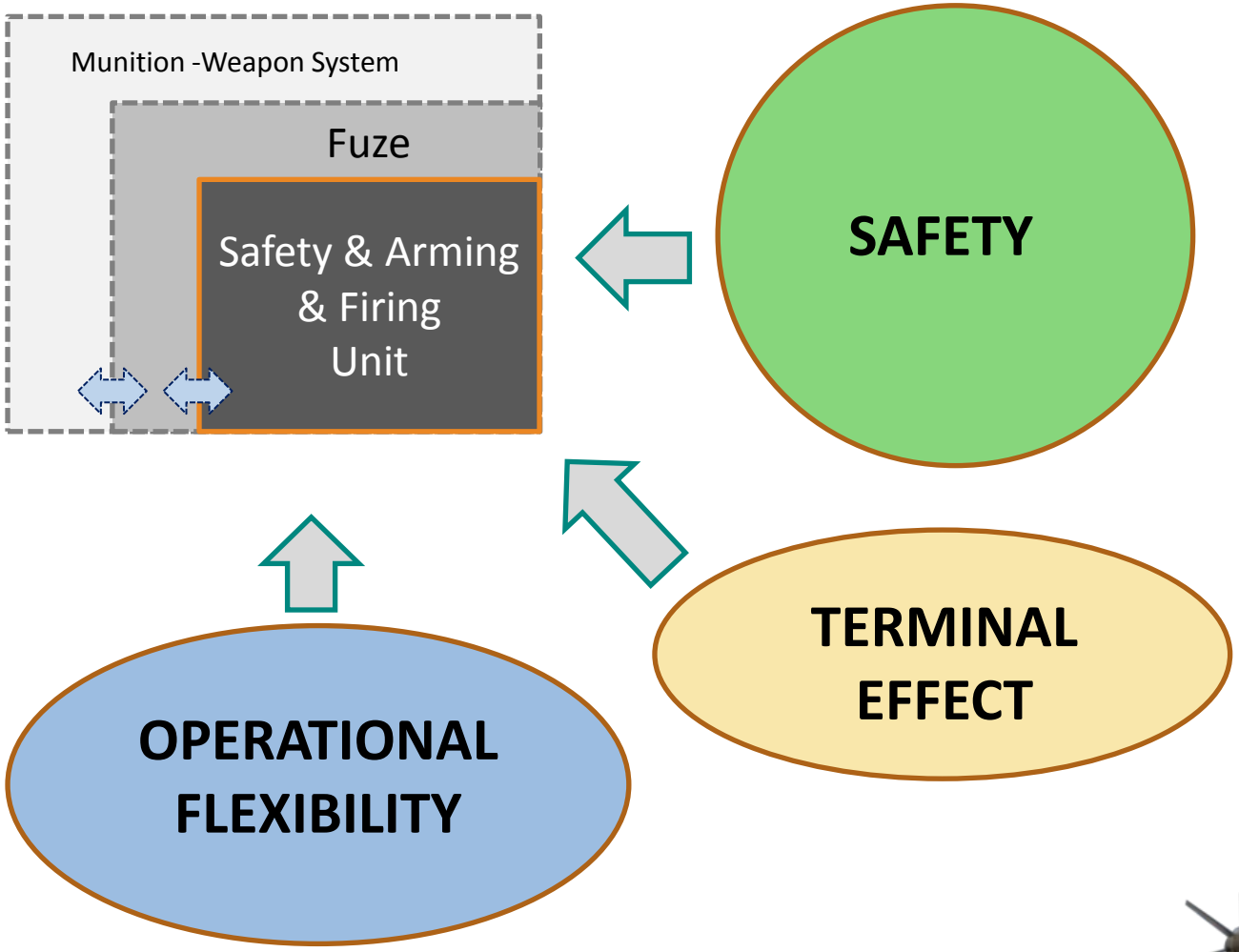
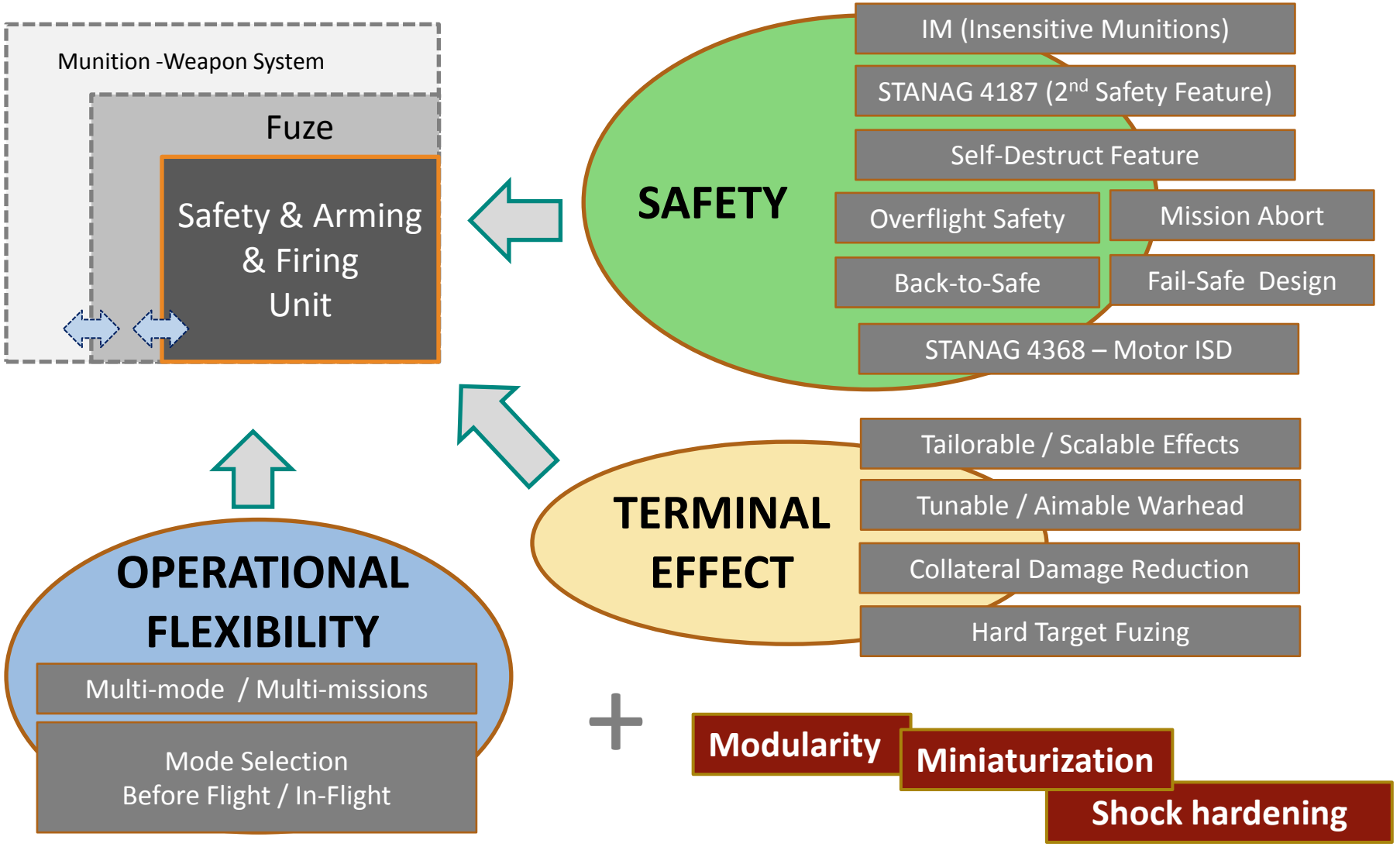



***New Needs for***

- **New Generation of Conventional Munitions**
- **"Smart" Munitions**
- **Guided Munitions**
- **Missiles**

# New Requirements – New Trends



# New Requirements – New Trends

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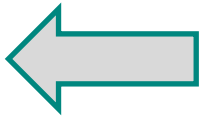
***Need for a* Safety, Arming and Firing *Function with***

- **New Functionalities**
- **More Flexibility**
- **More Control**



IM (Insensitive Munitions)

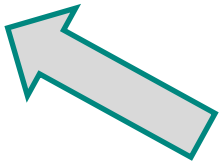
STANAG 4187 (2nd safety Feature)

Self-Destruct Feature

Overflight Safety | Mission Abort

Back-to-Safe | Fail-Safe Design

STANAG 4368 – Motor ISD



Tailorable / Scalable Effects

Tunable / Aimable Warhead

Collateral Damage Reduction

Hard Target Fuzing

Multi-mode / Multi-missions

Mode Selection
Before Flight / In-Flight

**Modularity**

**Miniaturization**

**Shock hardening**

# New Functionalities

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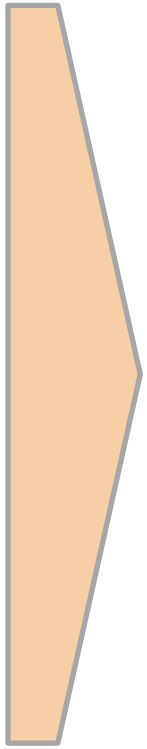
- Control of the arming sequence
- Activation / de-activation
- Arming / de-arming
- Programming / Control of arming delay
- Control of several initiation points - Timing Sequence
- Processing & Management of safety signals delivered by the weapon / munition
- Communication with the other modules from the fuze, munition or weapon system

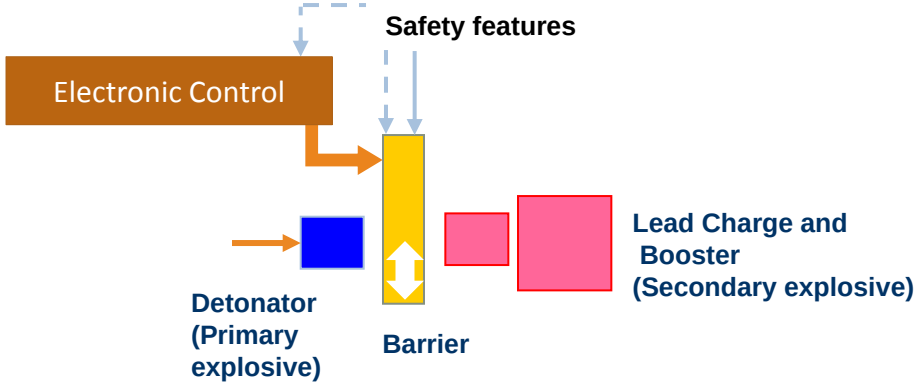


Needs
**Electronic Control**
of the Safety & Arming Function

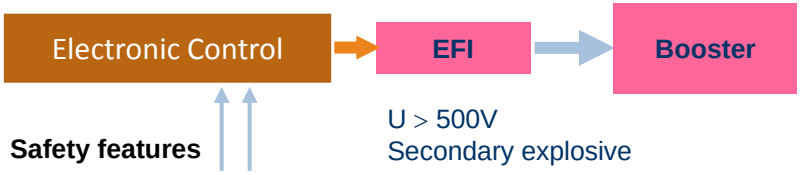
# Solution: SAD Electronically Controlled

- Need for control of the safe & arm functions: Electronic command of the SAD
- Two S&A Device technologies are suitable to achieve this function:

**Electromechanical SAD**




**Electronic SAD**




***In-line S&A Device***

# Electromechanical & Electronic SAD – Product Trends

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## Electromechanical SAD

**Now**

Missile and aerial bombs, some munitions

**Trend**

All type of munitions

## Electronic SAD

**Now**

High value missiles, Aerial bomb

**Trend**

Aerial bombs, small missiles, smart munitions

# Electromechanical SAD & Electronic SAD – Technology Trends

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- **The 2 technologies EMSAD and ESAD evolve and develop together, even in different ways**

## Electromechanical SAD

- Miniaturization
- More and more electronics
- New technologies

Microtechnologies
New materials and techniques
Metal, Plastic
Injection

micro-actuators

## Electronic SAD

- Size reduction
- Cost reduction
- LEEFI based Fireset

Low Energy EFI

HV Components

# New Challenges for the Fuze/SAD Designer

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- **Introduction of electronics in mechanical / electromechanical SAD design**
  - Power supply issues
  - Low power electronics
  - Low energy initiators
  - Design of safety architecture, Fail-safe
    - Hardware
    - Software
- **Resistance to more and more severe environments**
  - Specific integration techniques (electronics)
  - Potting technologies
  - Shock filtering and absorption solutions
  - Mechanical shielding solutions
- **Miniaturization**

# Electro-mechanical S&A Devices

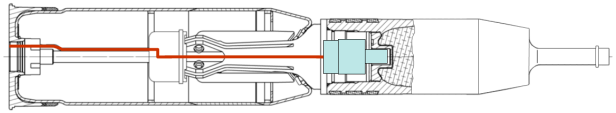
**Exemple of current, in-service product**

- **Tank Ammunition Fuze DM173 for DM11 round (120mm)**

- **Programmable fuze**
  - Impact - Impact Delay
  - Airburst (from 64ms to 12s)
  - Self- destruct

- **SAD operation**
  - Safety criteria: acceleration detection and gas pressure switch
  - Electronic control of the SAD arming with piston actuator

- **In production, in service with the German Army and the US Marine Corps**



# Miniaturized Electro-Mechanical SAD

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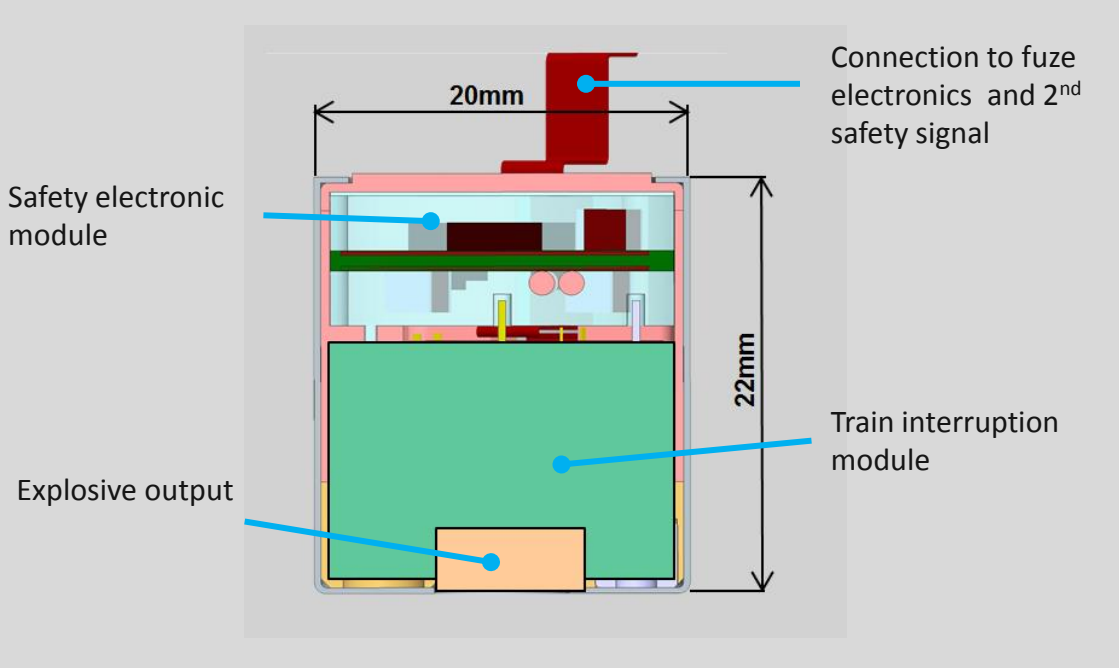
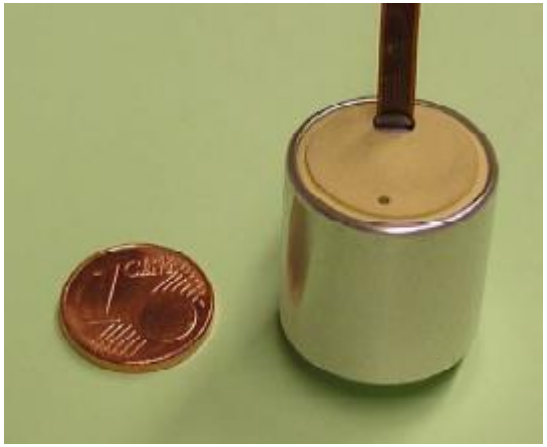
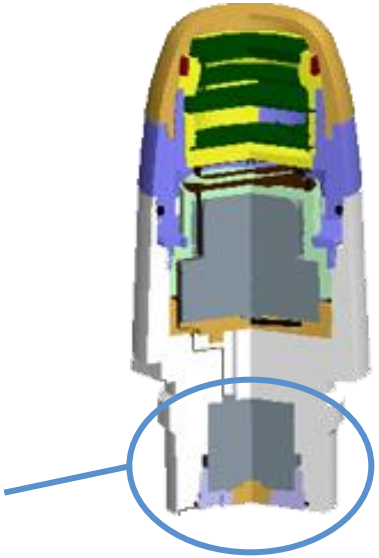


**Cylinder diam. 20mm x 22mm includes:**

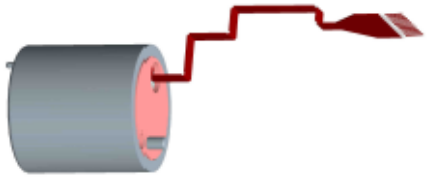
- **Safety electronics**
- **1st safety event**
- **Firing train interruption device**
- **Explosive train**
- **Piston actuator**
- **Explosive output**

*Integration in a mortar multi-function fuze*

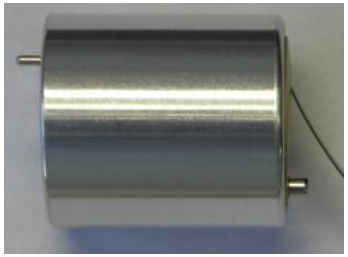


# Miniaturized Electro-Mechanical SAD

- **Qualified in tube launched environment (mortar)**
  - 1st safety event: setback acceleration, mechanical switch integrated in the SAD
  - 2nd safety event: provided by the fuze control electronic module (flight detection, electronic)



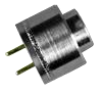
- **Adaptable to other type of munitions, with suitable external safety event**
  - "Smart" fuze and Guided munitions fuze, artillery, mortar, etc
  - Shoulder-launched weapon
  - Any other warhead S&A devices



# Electronic SAD, EFI-based

- **ESAD Main Benefits**
  - High level of insensitivity
  - Resistance to EM disturbances
  - Resistance to mechanical stress / shock
  - Flexibility

Electronic Unit, incl. Fireset



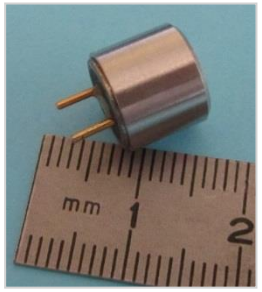
EFI

**Exemple of current, in-service product**

- **FBM21 Aerial Bomb Fuze**
  - Multirole Fuze: General Purpose and Penetration / Hard target capability.
    Proximity mode (with external sensor)
  - For use with 3" fuze pocket bombs, dumb or guided bombs, Paveway II & III, Enhanced Pw II & III, AASM (Hammer), JDAM
  - Based on JUNGHANS' EFI and fireset design
  - In mass-production since 2009, combat proven

# LEEFI based Fireset and ESAD

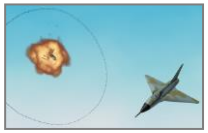
- **Main benefits provided by LEEFI technology**
  - Lower design constraints
  - Smaller size
  - Lower cost
  - Possible use of standard components




LEEFI

- **Running programme within JUNGHANS - Objectives:**
  - Get a qualified source for LEEFI and key components (HV switch), ready for product development in 2015
  - Rely on plug-in detonator solution, as used in the EFI technology
  - SAD size lower than 40cm$^3$
  - ESAD Modular design (Integration flexibility / Multipoint ignition warhead)
  - Enable the use of ESAD solutions in a broader range of applications, either in munitions or missile domain:
    - Smart munitions, small missiles, multipoint initiation warheads, Motor ISD

Wafer with fuzing bridges



# S&A Devices - The "Modularity" Issue

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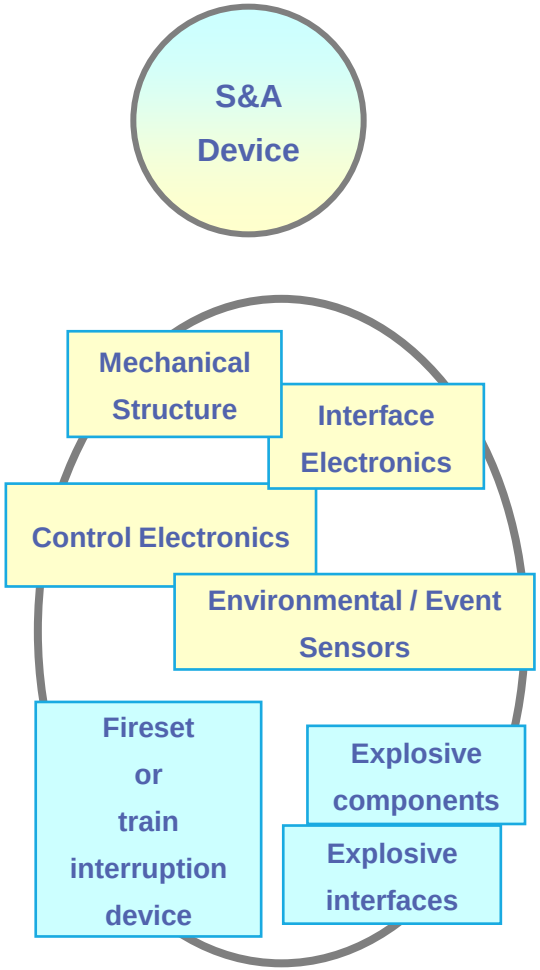
- **The ultimate wish**
  - Re-use of proven technical solutions/modules: "off-the-shelf" (or nearly OTS) "pin-to-pin" compatible device!
- **Main issue: Munition or Missile Applications often require:**
  - Specific interfaces, size, safety events/signals, power supply
  - Specific environment and stress resistance (hard target or not)
- **The realistic view**
  - Getting a real generic S&A solution is a problem
  - A more realistic option is to share and re-use basic design and common technology
    - Common architecture and design
    - for Electromechanical SAD : re-use the interruption train system and electronics
    - for ESAD : re-use the fireset and electronic architecture



# Conclusion

- **Modern S&A and firing devices have to deal with new requirements for munitions and missiles, in terms of performances and safety features**
- **New microtechnology solutions as well as electronic integration techniques lead to significant improvements in both Electromechnical S&A device and ESAD domains**
  - Providing additional functions to S&A Devices, suitable for modern use of munitions
  - Enabling the use of these technologies in a broader range of application

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# Thank you for your attention!

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