

Course Correction Fuzes Integration Technologies

55th Annual Fuze Conference
"Fuzing's Evolving Role in Smart Weapons"

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Outline

- Course Correction Fuze – Main technology issues
- Main functions
- Technology evolutions and technical challenges
- Example of current Course Correction Fuze programmes
- Integration solutions for 1D-CCF
- Future trends
- Conclusion

Company Presentation

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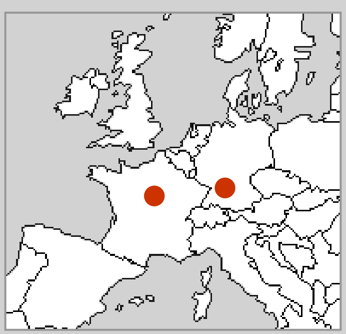
- **A leader in the field of ammunition fuzes and S&A devices**
- **Full range of products**
- **Key competences in**
  - Fuzing technologies
  - Micro-technologies
  - Ammunition electronics



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Course Correction Fuzes
Main Technology Issues

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- Standard fuze size
  - Fitted on conventional munitions




- Additional functionalities and performances, in a fuze enveloppe
  - Fuzing functions (MOFA type)
  - + Course correction functions
    - Electronics and guidance device


- Gun environment
  - Ramming / Firing
  - Standard interfaces with weapon systems
  - Data link with weapon system
    - Before flight / during flight





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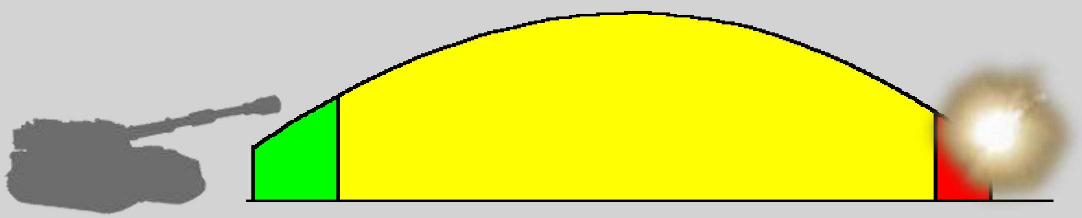
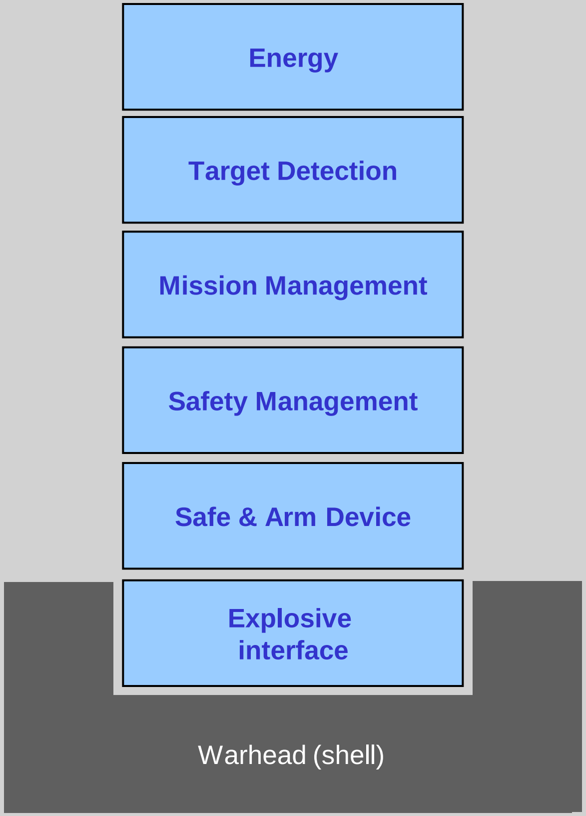
CCF – Main Functions

- Fuzing functions and modules
  - Safety
    - Safety environment sensors + safety management + firing train interruption
  - Mission management
    - Data-Link with weapon, before and/or in-flight (mission parameter programming)
  - Target detection :
    - Sensors + processing + triggering decision
  - Warhead initiation
    - Firing train + interfaces





CCF – Main Functions

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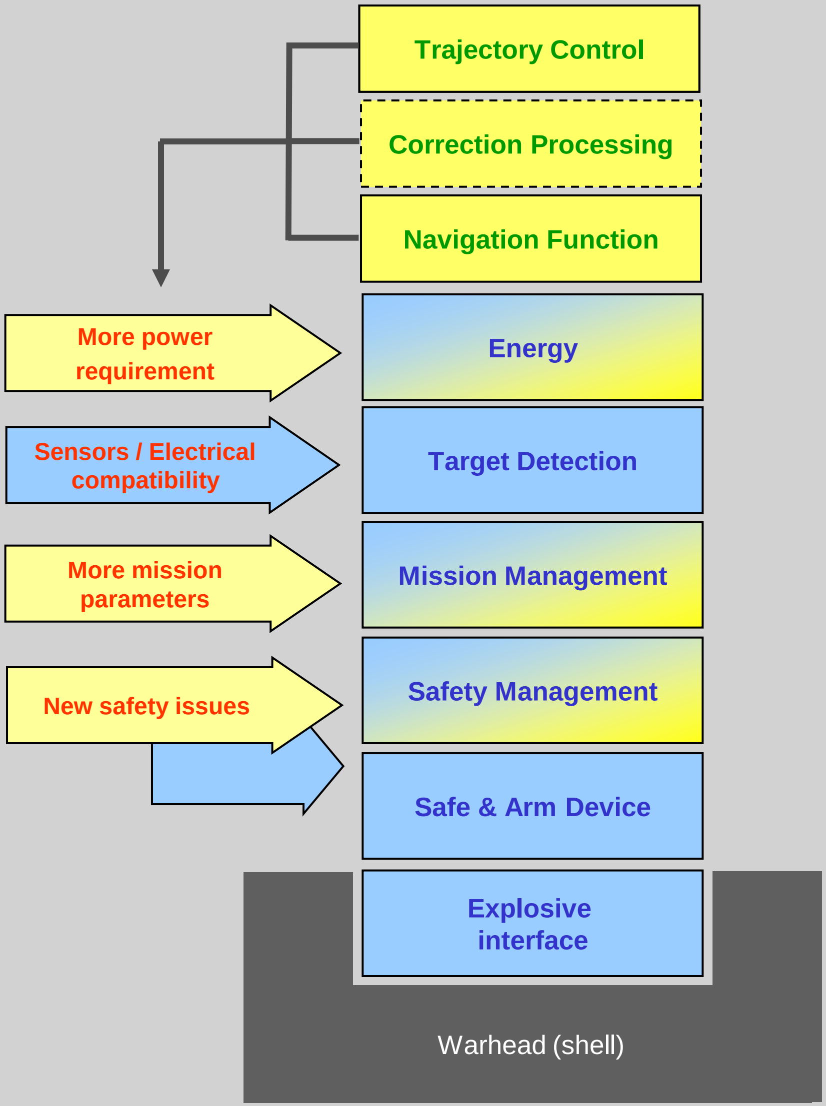
- Fuzing functions

  +

- Course Correction Functions
  - Navigation Function: trajectory estimation
  - Correction Computing: algorithm + processor
    - Fuze embedded processing
    - or Weapon system processing
  - Trajectory Control: air control device + actuators

- The implementation of these functions has an impact on the requirement and the design of the fuze's other functions



Technology Evolutions
Fuzing Functions

- Fuzing functionalities and capabilities have been significantly improved due to the electronic and sensor technology evolution (dual use components)
  - More versatility, operational flexibility, target detection performance
    ➔ Multifunction fuzes
- Difficult to get the same technology progress with non-electronic and specific fuze modules

Energy	Reserve Battery
Target Detection	Sensor miniaturization Electronic integration
Mission Management	Electronic integration
Safety Management	Sensor miniaturization Electronic integration
Safe & Arm Device	Safe & Arm Device
Explosive interface	Explosive interface

Electronic related technologies
➔ High level of integration can be achieved

Mechanical / Chemical technologies
➔ Miniaturization is more challenging

Technology Evolutions
Course Correction Functions

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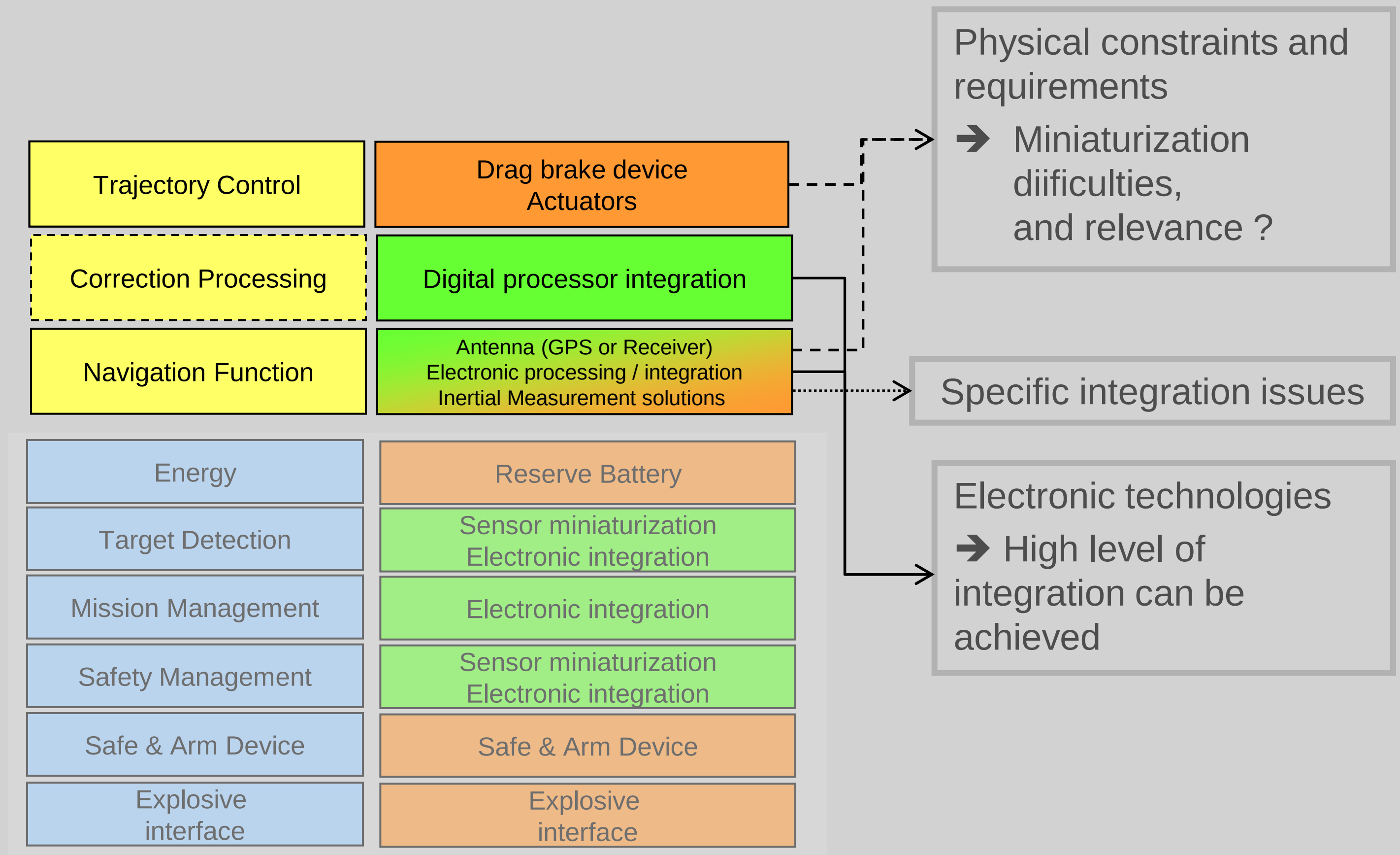
- Implementation of Course correction functions
  - Require significant space in the standard fuze architecture
  - Use various technologies which cannot be highly integrated



CC Fuze Development
Main Technology Challenges

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- Main objective: Low-risk – low-cost design approach
  - Leverage in-service modern fuze design
  - Use existing qualified components
- Main challenges
  - Comply with the standard fuze size: STANAG 2916 contour / short intrusion
  - Re-use available sub-assemblies, in their current design
  - Optimise the integration for some of the fuze functions to provide space for the additional course correction functions
  - Cope with available (autonomous) power supply
  - Deal with compatibility issues between the different technologies living together in a small space, in particular:
    - Electromagnetic compatibility and interference issues within the various electronic circuits
    - Various antenna type integration, for different purposes, inside the fuze enveloppe

CC Fuze Development
Example of current CCF programmes

- JUNGHANS is today implementing integration solutions in major course correction fuze programmes carried out in Europe
  - Relying on modern multifunction fuze architecture and proven modules and components
- Two concepts based on different navigation and localization solutions:
  - ➔ very different concept and design
  - ➔ different integration problems and solutions
  - ***SPACIDO* Fuze**: in co-operation with NEXTER, France
    - "Non-GPS" trajectory navigational system solution Trajectory estimation based on the projectile initial velocity measurement by the muzzle velocity radar (MVR)
    - Range correction order sent to the fuze by the MVR
  - ***ECF* (European Correcting Fuze):** in co-operation with BAE Systems, UK, (GCSM) and Sweden (GCSW)
    - GPS based solution
    - Trajectory estimation based on the use of GPS C/A receiver

SPACIDO System

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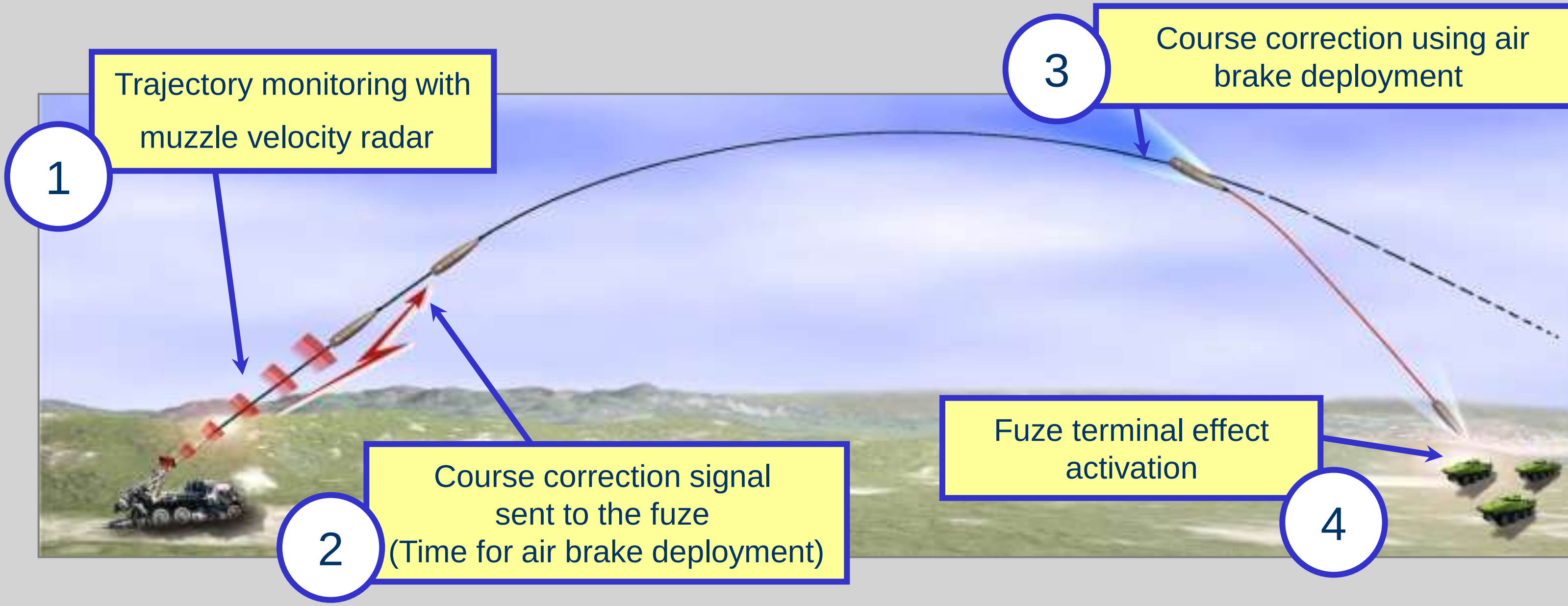

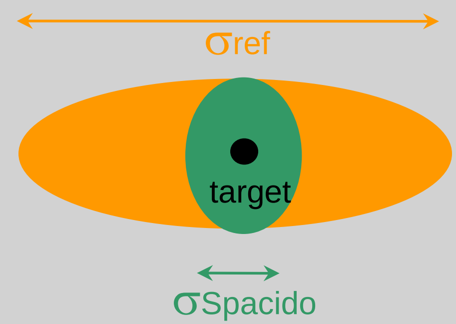

- **In cooperation with** nexter MUNITIONS

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SPACIDO

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Fuze Integration Technologies

Course Correction Fuze

ECF (European Correcting Fuze)

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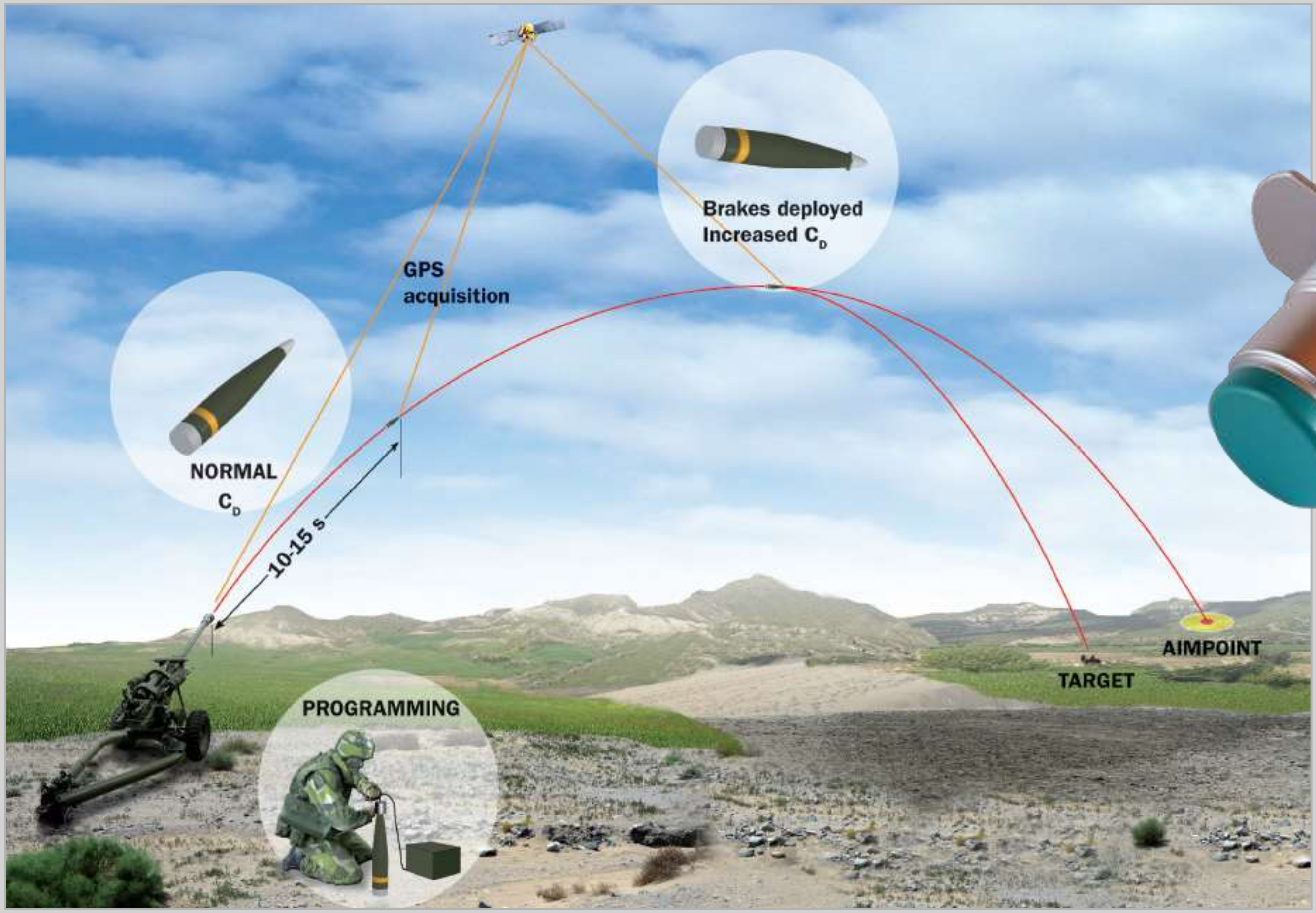
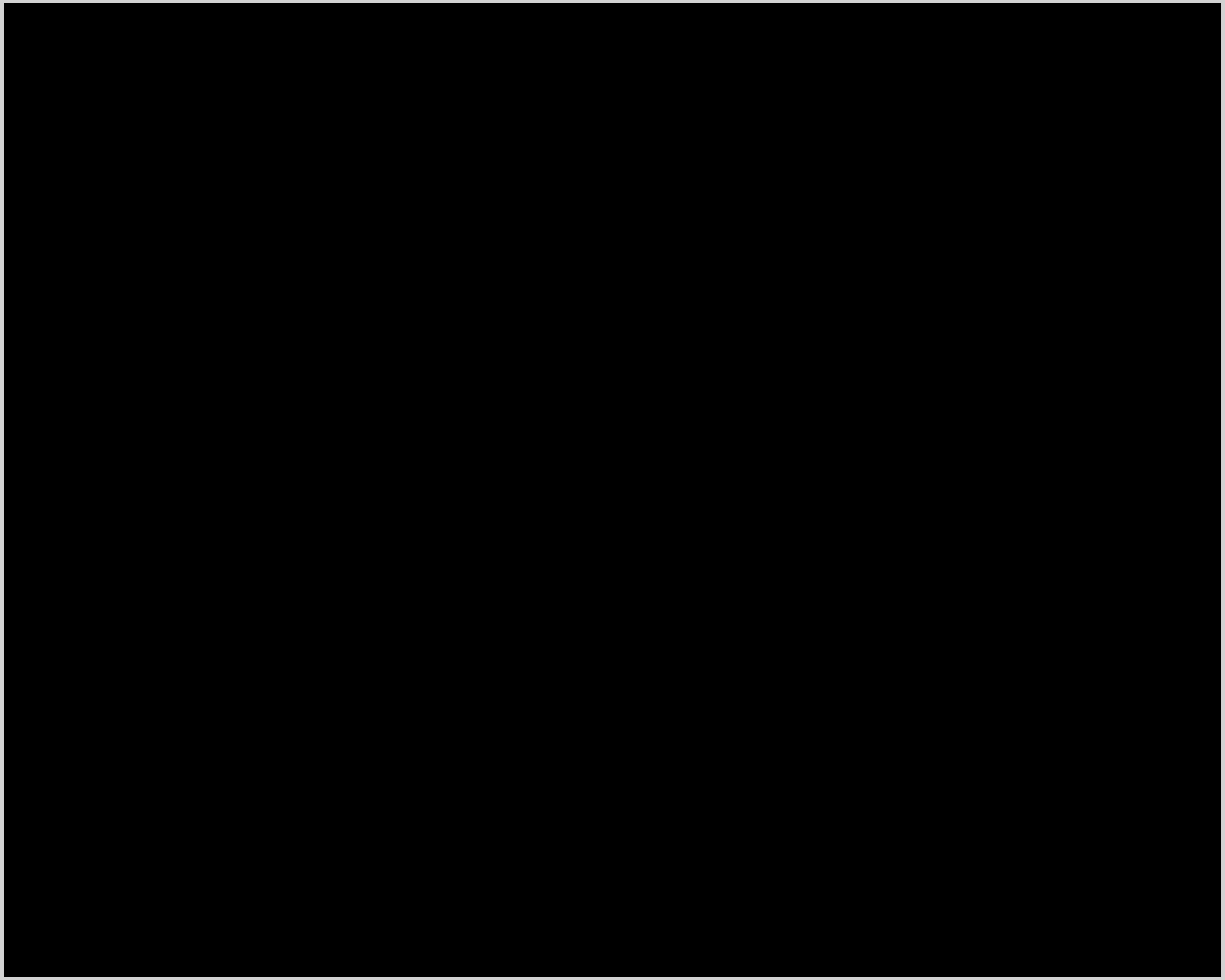


- **In cooperation with** BAE SYSTEMS

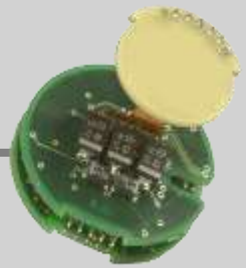
ECF



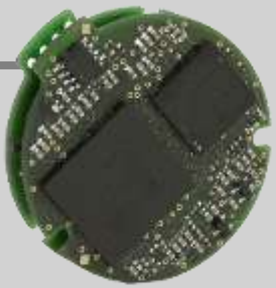
Integration Solutions for 1D-CCF
Basic Options

- Re-use proven sub-assemblies, as they are
  - Reserve battery - Lithium
  - Mechanical Safe & Arm Unit
  - Even if they are bulky items,
  - ➔ More cost effective and less risky

- Re-use target detection device (HoB sensor)
  - ➔ Slight adaptation to cope with space compatibility with other electronic boards, but same design



- Share the processing unit between target detection signal processing and correction processing
  - ➔ Select suitable component to cope with computation power requirement



Integration Solutions for 1D-CCF

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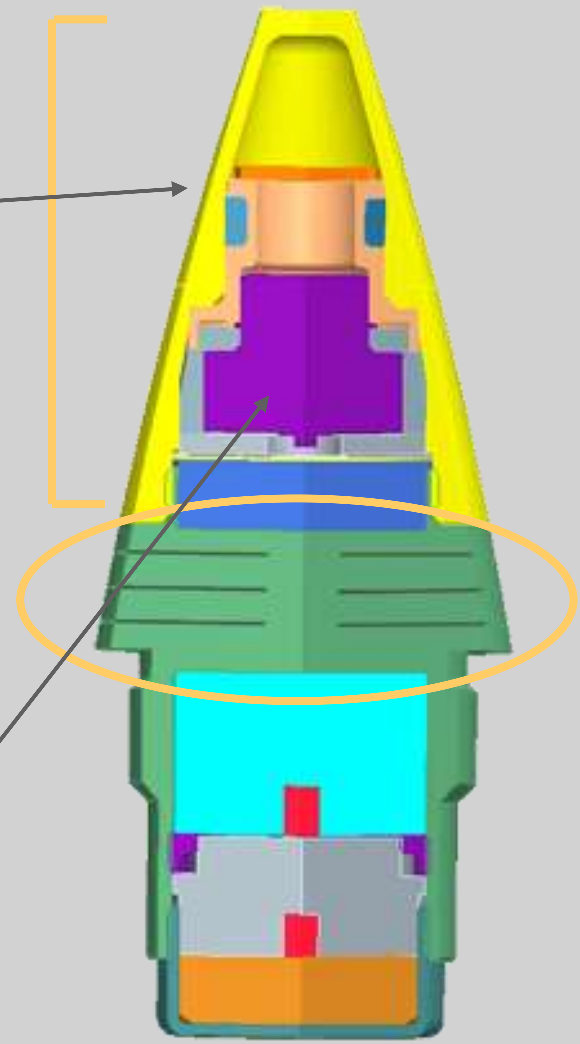
- 1D-CCF are fitted with drag brake device located in the central part of the fuze
  - Benefit: The nose cone of the fuze is free for antenna and radome integration
    - SPACIDO: Data-link receiver with antenna
    - ECF: GPS receiver and antenna
- Power requirements for 1D-CC
  - Aerodynamical control devices do not need high power actuators
  - Functioning of the various fuze modules and related power consumption can be managed all along the flight
    - Benefit: The power requirement is compatible with current reserve battery features



Integration Solutions for 1D-CCF

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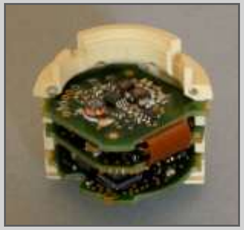
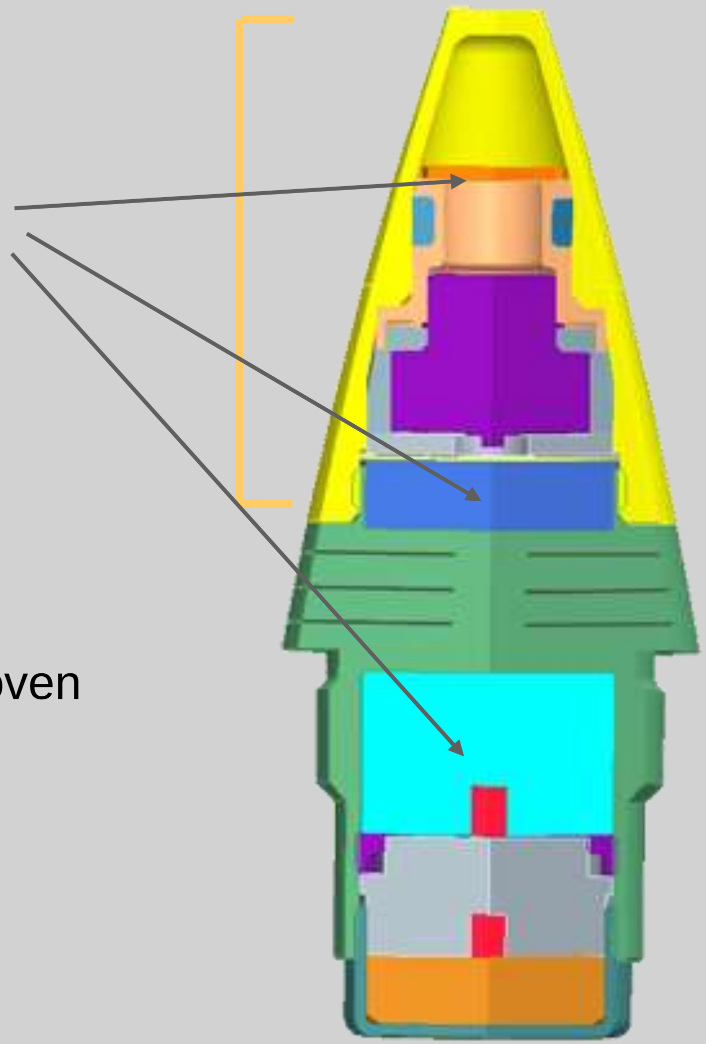
- Board interconnection techniques
  - More constraints: numerous boards, more data, no space available for connections, testing requirements
  - Optimized architecture to reduce interconnections
  - Flexprint circuits





- G-hardening
  - Possibility to keep and implement proven techniques from modern electronic artillery fuzes
    - Fuze frame design
    - Electronic board design
    - Potting material and techniques

Integration Solutions for CCF
Antenna Integration

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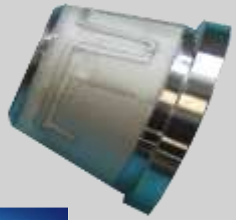
- SPACIDO
  - Integration of an embedded data-link receiver
    - receiver / decoder board
    - with "looking backward" antenna
  - Compatible with other modules requiring external access
    - STANAG 4369 programming coil
    - HOB sensor antenna and signal processing board

- ECF
  - Integration of an embedded GPS receiver
    - GPS receiver board
    - with antenna (revolution symetric radiation pattern)
  - Compatible with other modules requiring external access
    - Programming interface for high-rate data transmisison
    - HOB sensor antenna and signal processing board



Other integration issues and technology solutions

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- Interference problems between the different electronic modules operating in a very close vicinity
  - Converters, processors, oscillators, etc

→ No room for physical shielding: Therefore the design requires very fine optimization (PCB layout, circuit frequency selection)

- Data-link for fuze programming before flight
  - Low rate or high-rate depending on the required mission parameters (Fuzing parameters, GPS ephemeris, etc..)

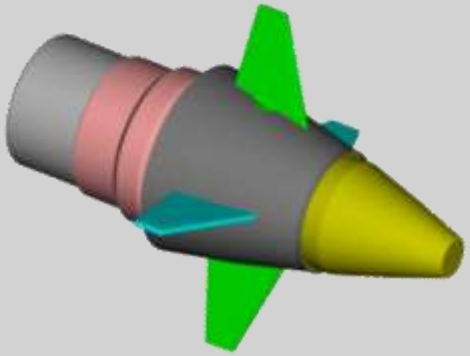
→ Optimization of the communication protocol to lower hardware and software constraints

- … and always
  - Keep good reliability
  - Keep high level of survivability to harsh conditions created by gun firing
    - High-G hardening on new technologies

Trends for guidance integrated fuzes

- Integration of future CCF concept or guidance integrated fuzes:
  - Much more tricky issue to keep all functions fitted into a standard short intrusion fuze enveloppe
  - Difficult to re-use conventional fuze components

- Some new challenges:
  - Guidance solutions
  - Navigation, incl. Inertial Measurement
  - New safety issues for the artillery systems
  - High-G hardening of new technology devices



- Some technological breakthrough will be required to meet the requirements in terms of:
  - Miniaturization, cost, reliability, safety for such products

Conclusion

- Course Correction Fuze development has created significant technical challenges to the fuze designer who has now to integrate new functionalities in the same fuze enveloppe
- Thanks to the progress achieved in electronic technologies but also in the fuze integration techniques, it is now possible to design smart fuzes featuring significant functionalities, including course correction capability
- JUNGHANS has taken on the technological challenges and has implemented solutions
  - To provide the user with smart fuzes, but still affordable and reliable
  - To prepare the technological breakthrough required for future fuze generation

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