43rd Gun & Missile Conference

Raytheon

EXCALIBUR

M982

Naval Sea Systems Command
Dahlgren Division
NAVAL SURFACE WARFARE CENTER
NSWC
DAHLGREN DIVISION

ARMS
ARTILLERY MUNITIONS SYSTEMS

Presented by:
Mr. Perry Salyers

April 21 – 24, 2008

L3 communications
KDI Precision Products, Inc.

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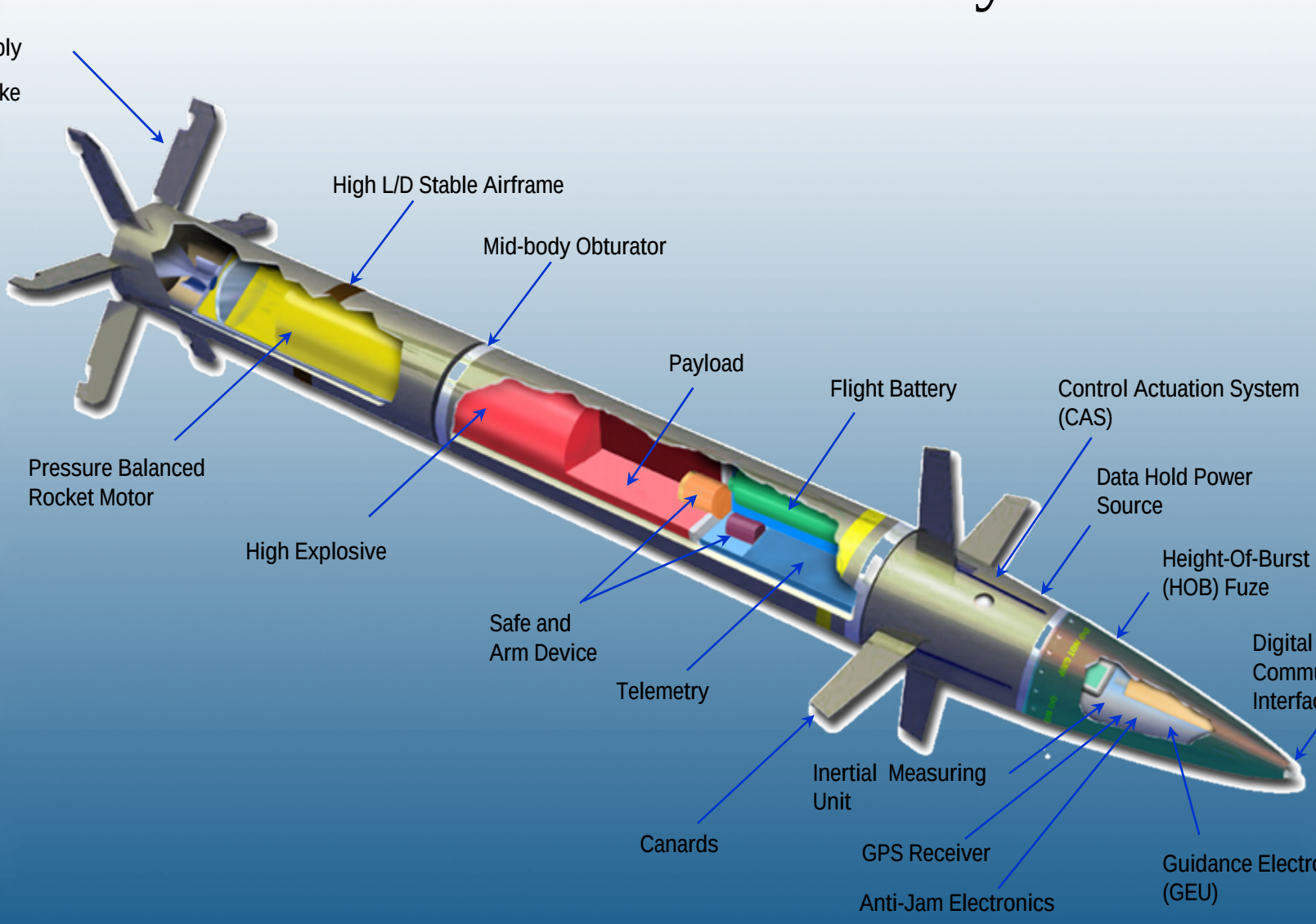
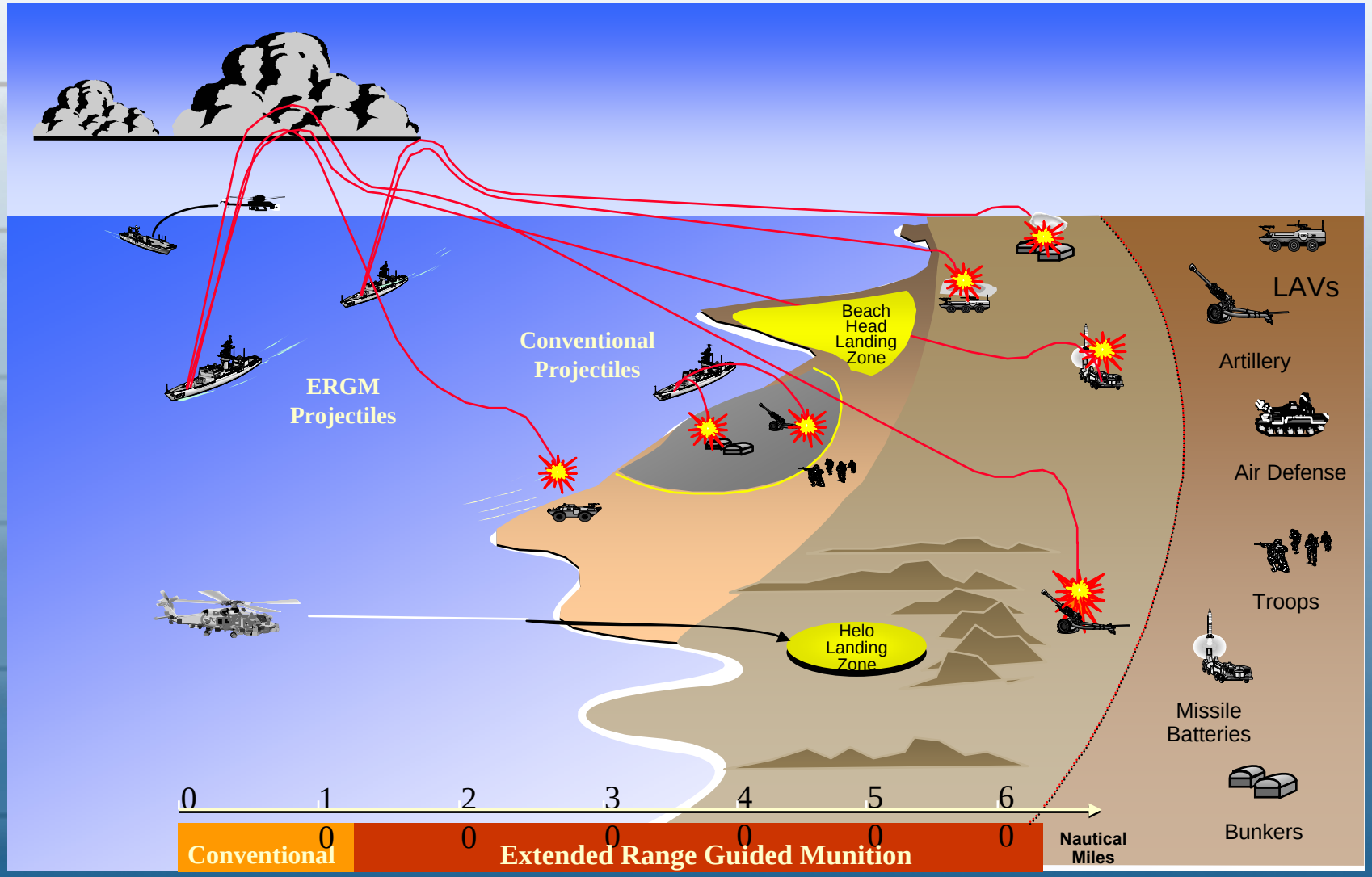
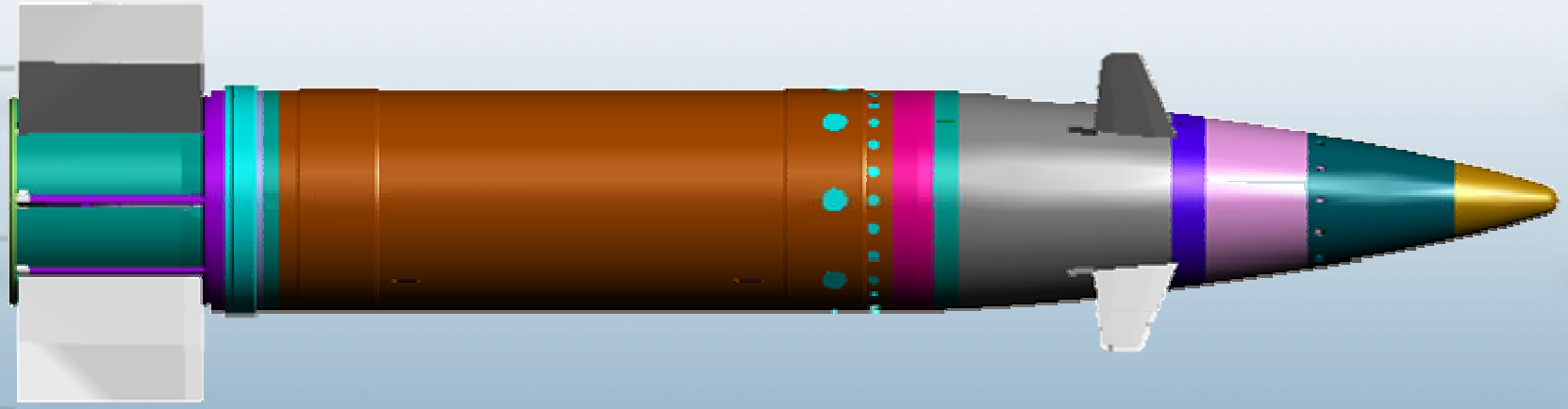
EX171 ERGM Tactical System



EX171 ERGM OPERATIONAL CONCEPT



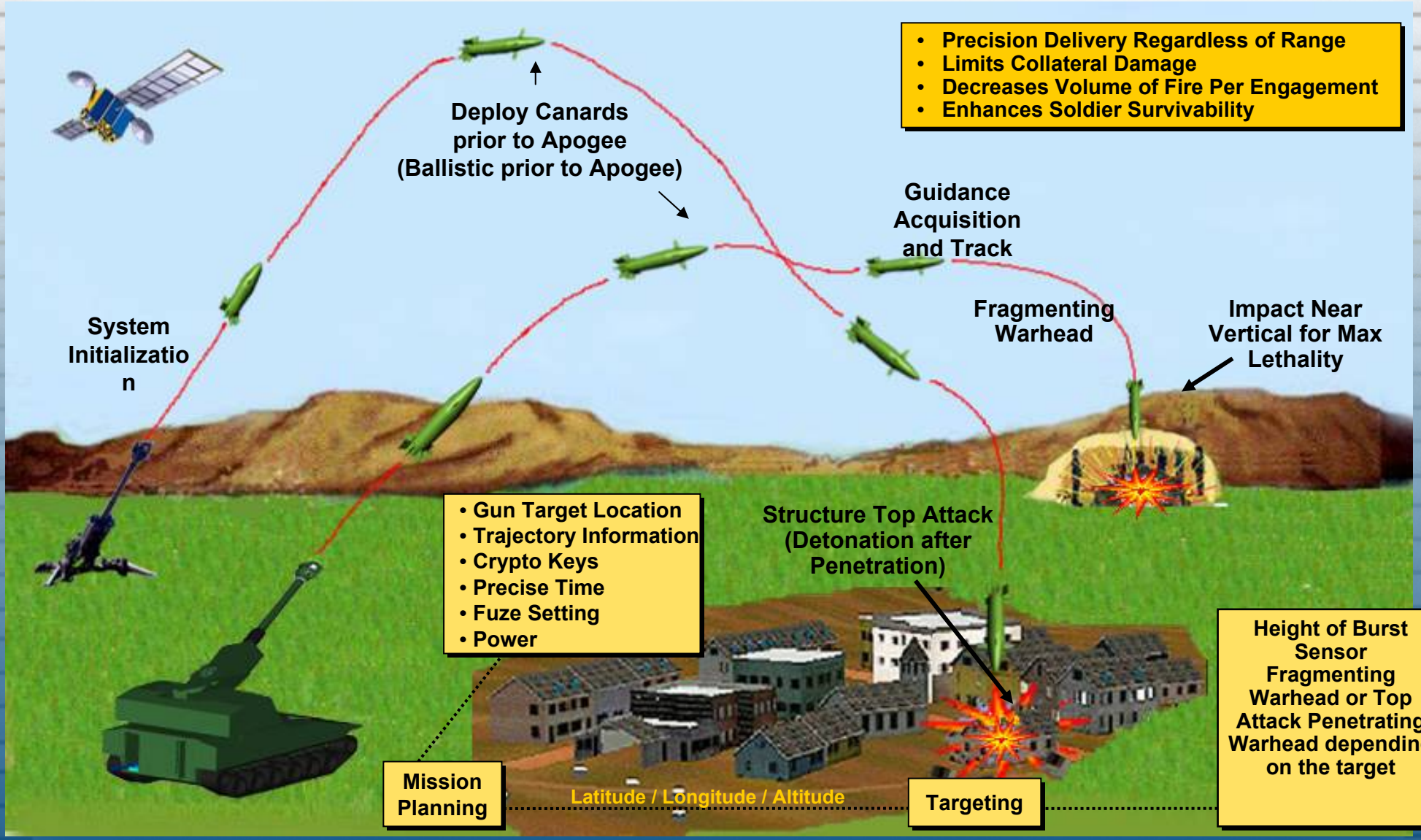
Excalibur (M982) System Overview



Characteristics/Description:

- 155MM Extended Range guided projectile
- Fin Stabilized Glide Air Frame
- Inductive Set with Enhanced Setter
- Inertial Navigation System (INS) Guidance
  - All Weather, Day and Night
  - Compatible with JLW155 & FCS Digitized
- 155mm Platforms
  - One Meter Length / 106 lb
- Warhead: Unitary
- Accuracy: 10m CEP objective
- Range: 40Km objective
- Targets : Personnel, light materiel, structures
- Fuze modes: PD, PD delay, Prox
- Environments:
  - 15.5 KG set back
    - Early fielding ~12KG
  - 50+ KG penetration

Excalibur Unitary Concept of Operations



Excalibur Characteristics Unitary Targets

Infantry Platoon

Excalibur: 3 rounds
M549: 25 rounds
M107: 43 rounds

Radar

Excalibur: 1 round
M549: 10 rounds
M107: 11 rounds

- ~10m CEP
- Same lethality as an 155 mm HE

System used in a complex target environment!

Excalibur at any range

M549 at 20Km

M107 at 15Km

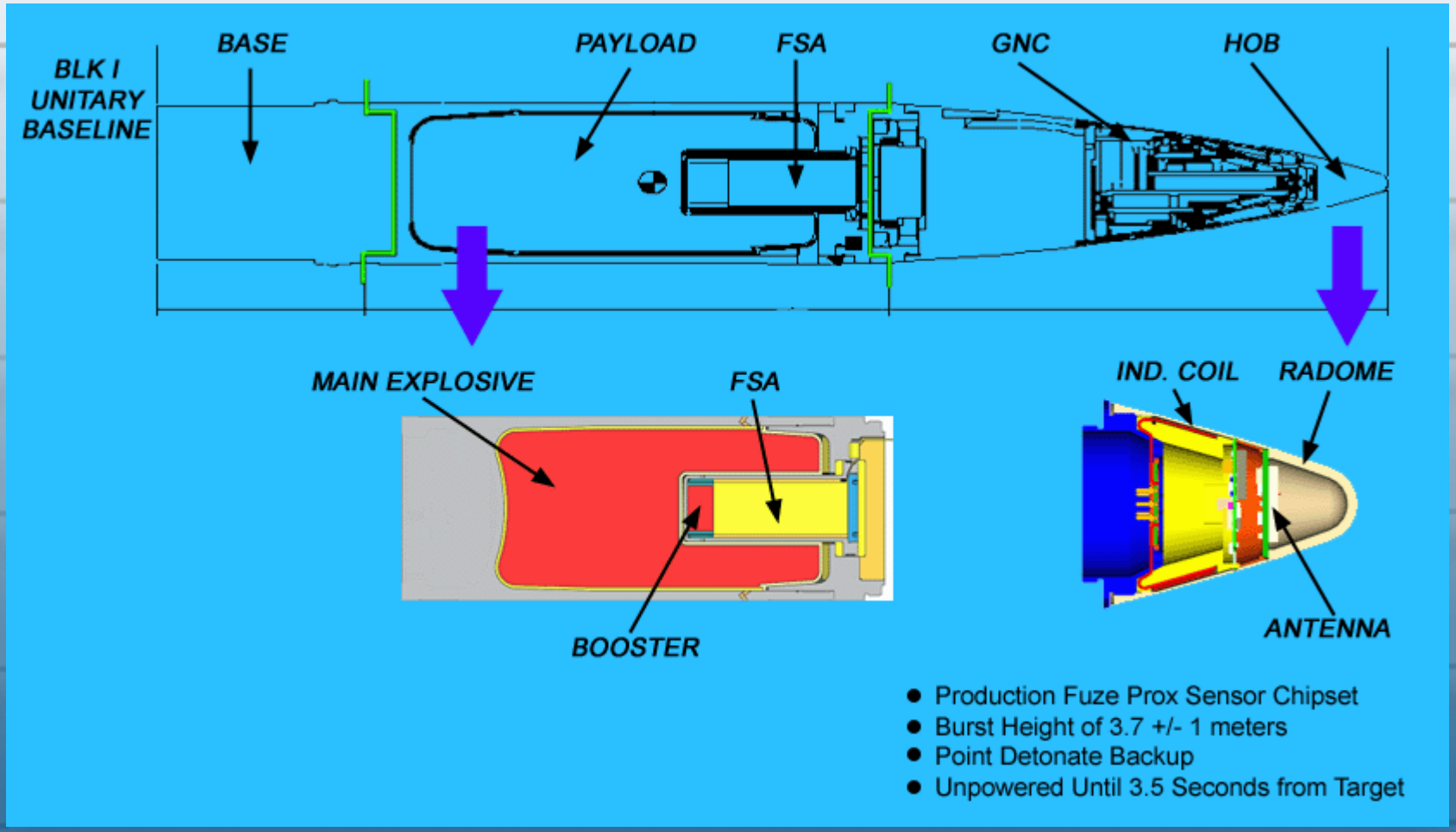
Command Post

Excalibur: 6 rounds
M549: 54 rounds
M107: 78 rounds

Structures

Excalibur: 3 rounds
M549: 147 rounds
M107: 110 rounds

Excalibur Fuzing System (FS&A w/HOB)



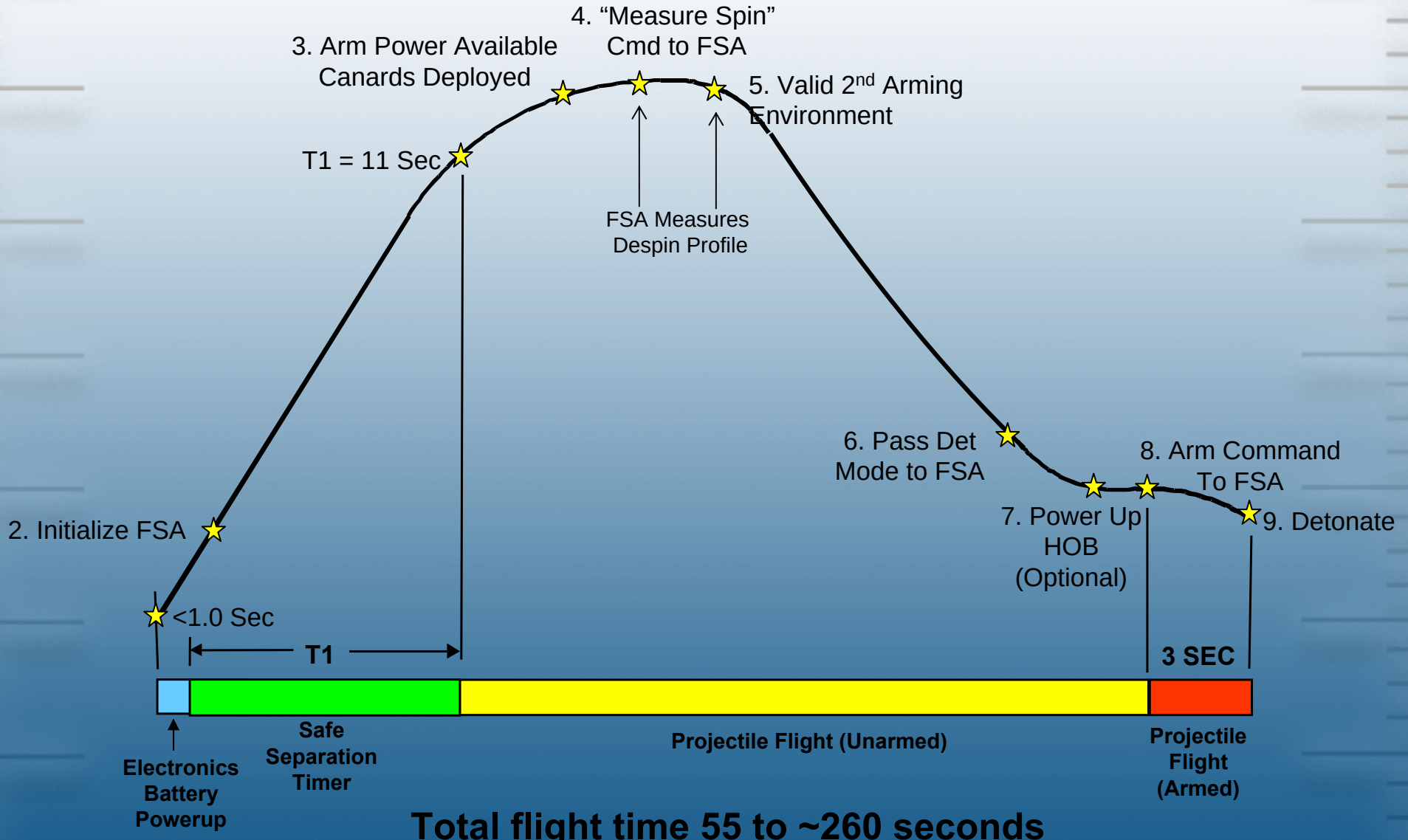
- Production Fuze Prox Sensor Chipset
- Burst Height of 3.7 +/- 1 meters
- Point Detonate Backup
- Unpowered Until 3.5 Seconds from Target

FS&A REQUIREMENTS

- Projectile Application
  - All Arm - 1,700 G's
  - No Arm - 300 G's
- Spin
- Interface With GN&C
- MIL-STD-1316D Compliant

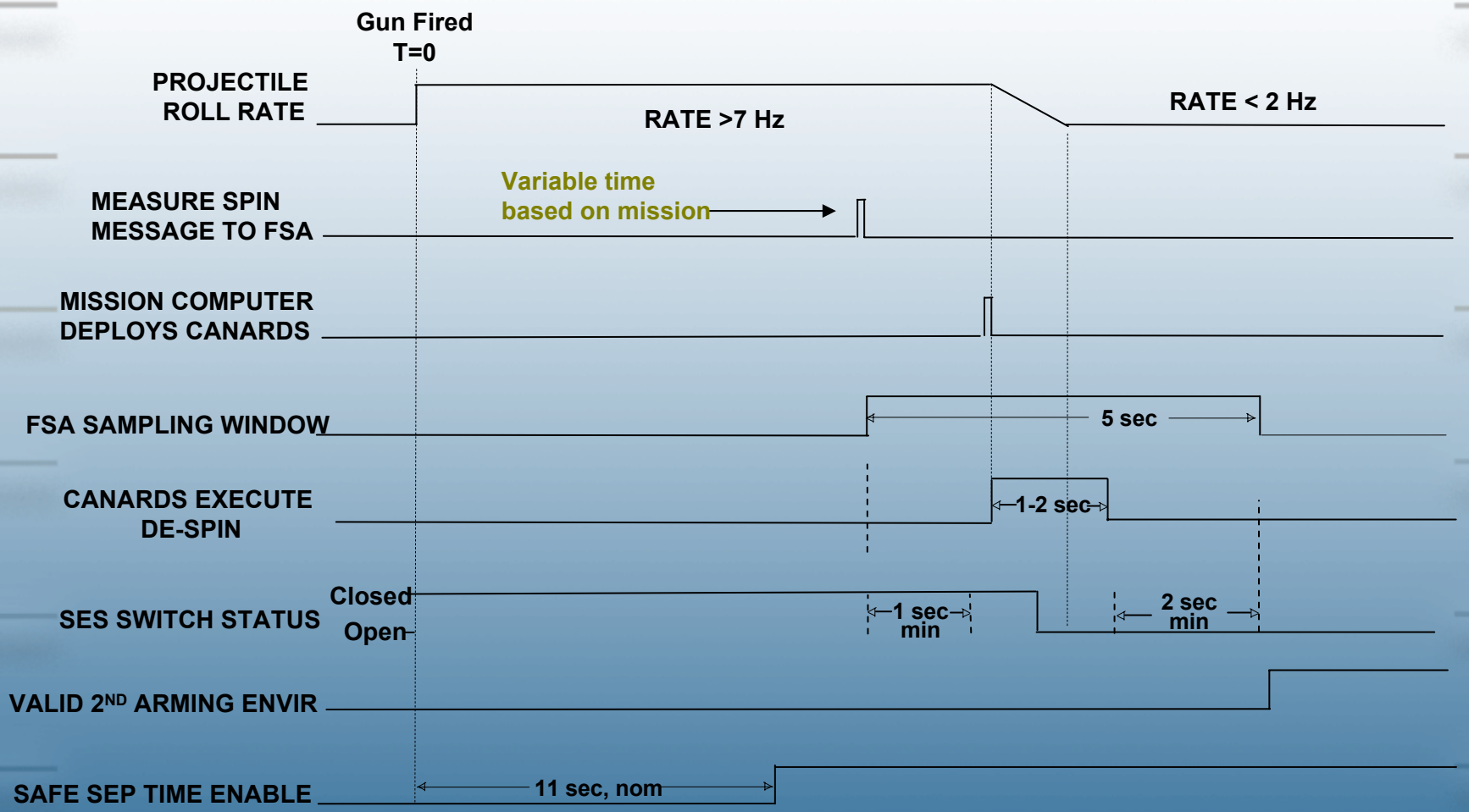
ERGM and Excalibur Mechanical S&A

Excalibur FSA /Flight Timeline



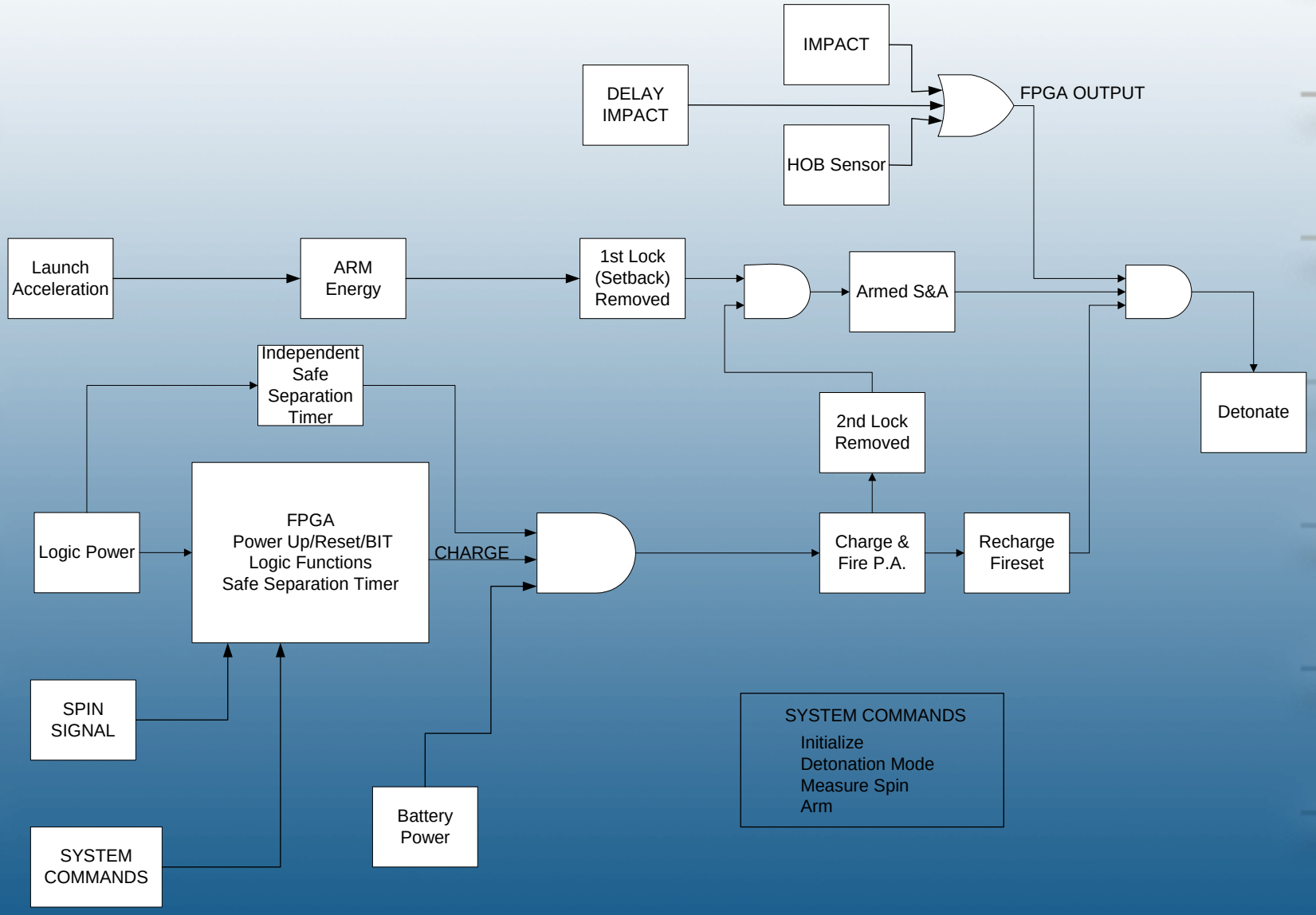
Total flight time 55 to ~260 seconds

2ND Arming Environment Timeline



- Unique Excalibur spin profile
- Spin switch closed initially (spin rate >7hz)
- Spin switch opens after canard deployment (spin rate <2hz)
- Delta spin detected within 5 second window where canard deployment occurs
- Allow 2 seconds after canard deployment event for dampening of mechanism

Excalibur FSA Logic Diagram

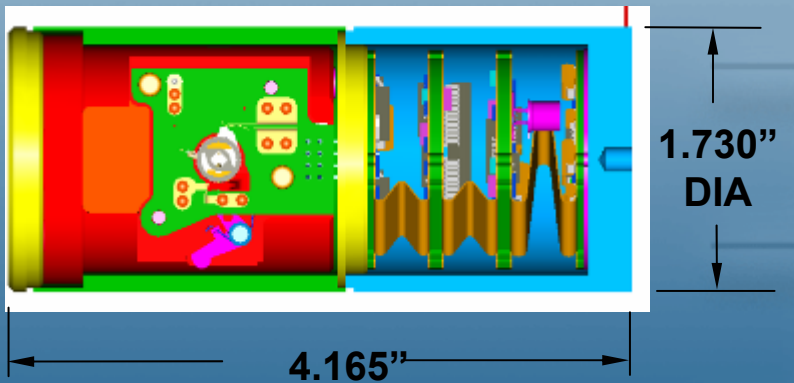


Excalibur Fuze Safe & Arm (FSA) Description

Key Features

- FSA consists of electronics module and mechanical module
- First Arming Environment is setback acceleration implemented mechanically
- Second Arming Environment is detection of de-spin event using a “g” switch
- Safe separation via independent timers
- Point Detonate fuze is implemented by a g-switch opening at impact.
- Delay after Point Detonate implemented by electronic timer
- HOB function implemented by RF proximity sensor using production fuze components

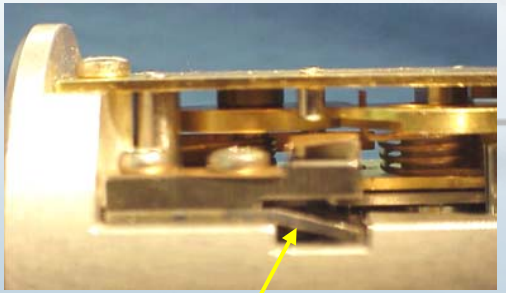
Mechanical Section	Electronics Section
Out of Line Mech Setback G-switch Rotor Control Detonator Shorting Detonator Output Lead	FPGA Power Up Logic Power Separation Timing Circuits Spin Sensing Arming Control Firing Control



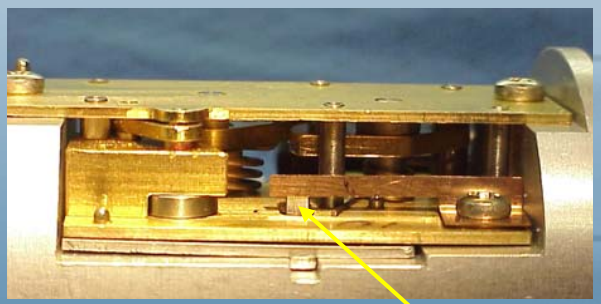
FSA Design Approach Concurred by Army & FMV Fuze Boards

S&A MECHANICAL DESIGN APPROACH

- Mechanical S&A Design Approach
  - Modified MK18 S&A
    - Higher G Loads
    - AFT Detonation Output
    - Switches Indicate Rotor Position
    - Integrated Electronics Control
  - Three (3) Leaf Set Back Mechanism



Second Rotor Lock (Safe)

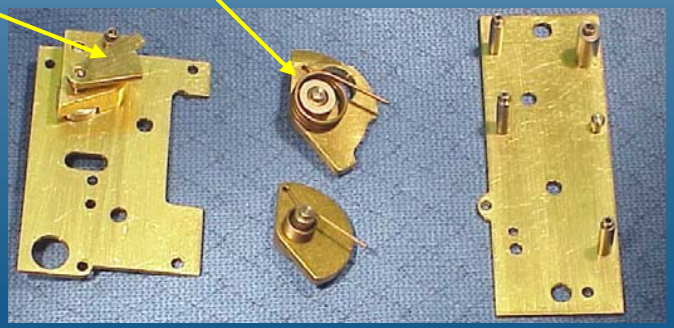


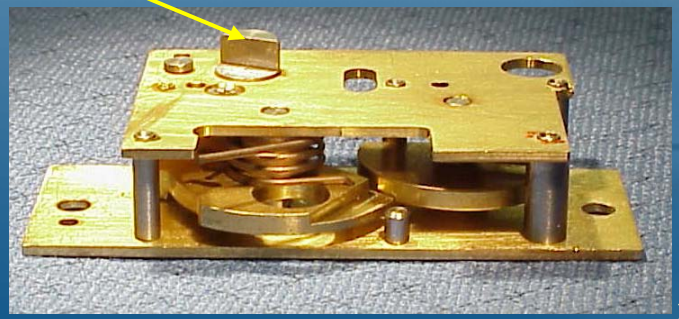
Rotor Lock (Arm)

Leaf Lock

Rotor Drive Spring

First Rotor Lock (Safe)

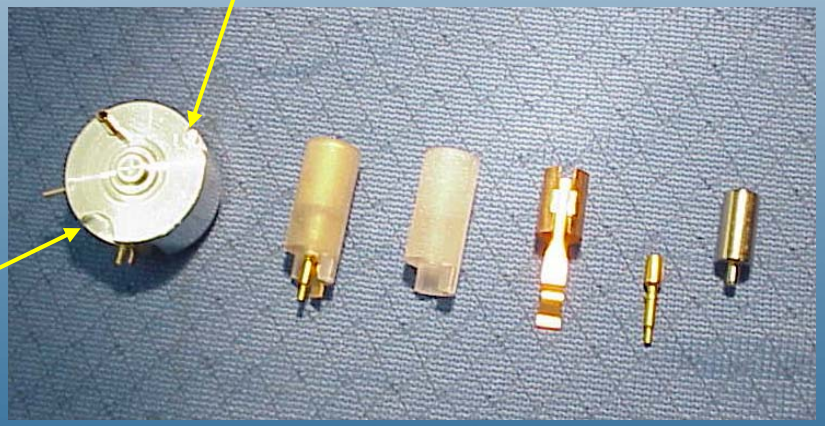




S&A ELECTRICAL DESIGN APPROACH

- S&A Electronics
  - RS232 Serial Communication Link
  - Codeword Controls Function

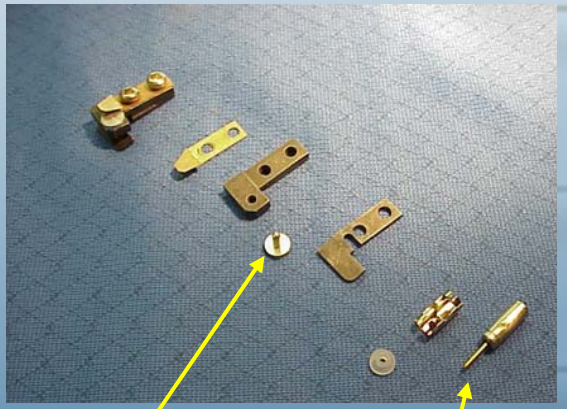
Second Safety & Arm Lock



Set Back Lock

Rotor W/Switches & M84 Detonator

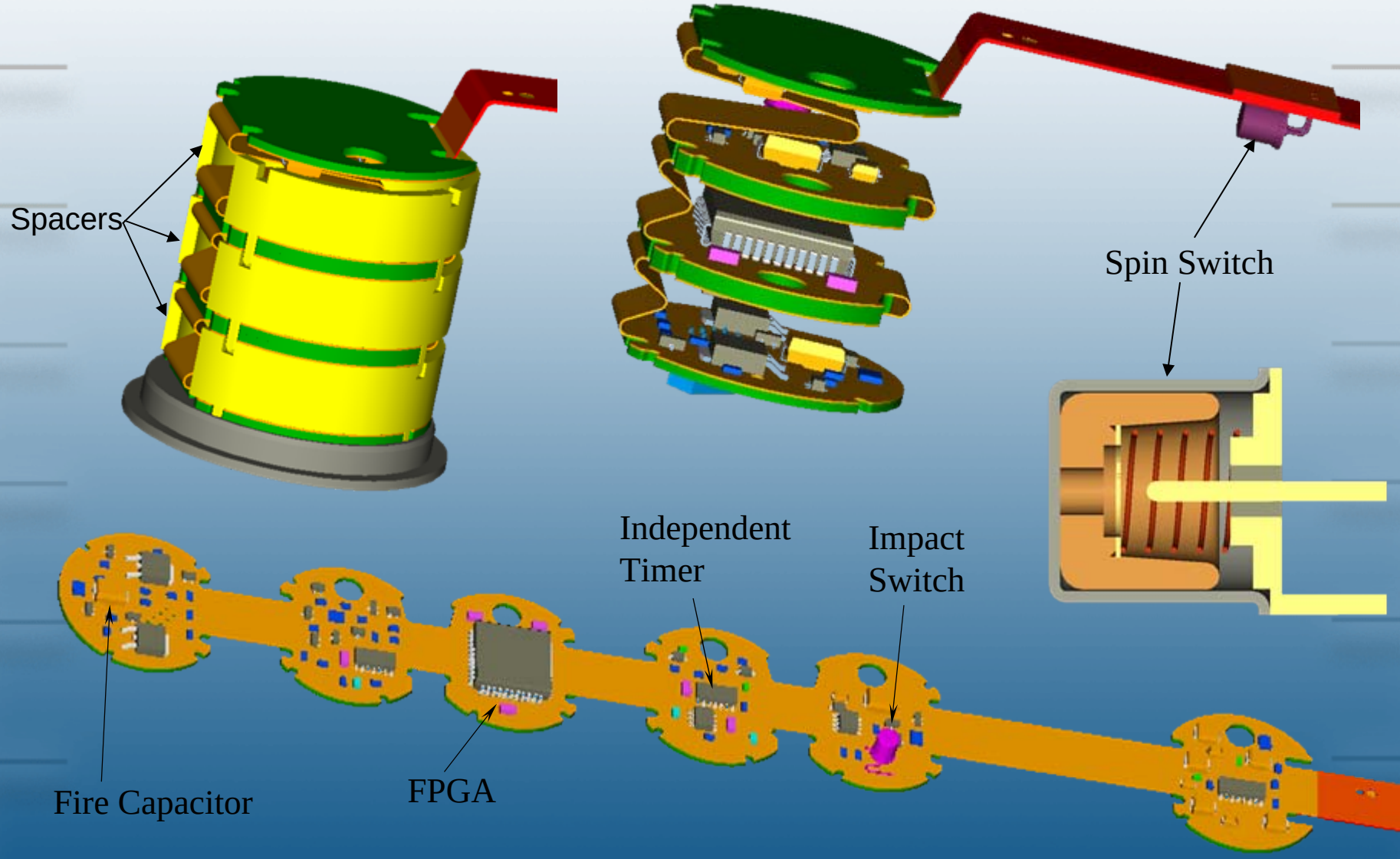
GN&C
Second Rotor Lock W/PA



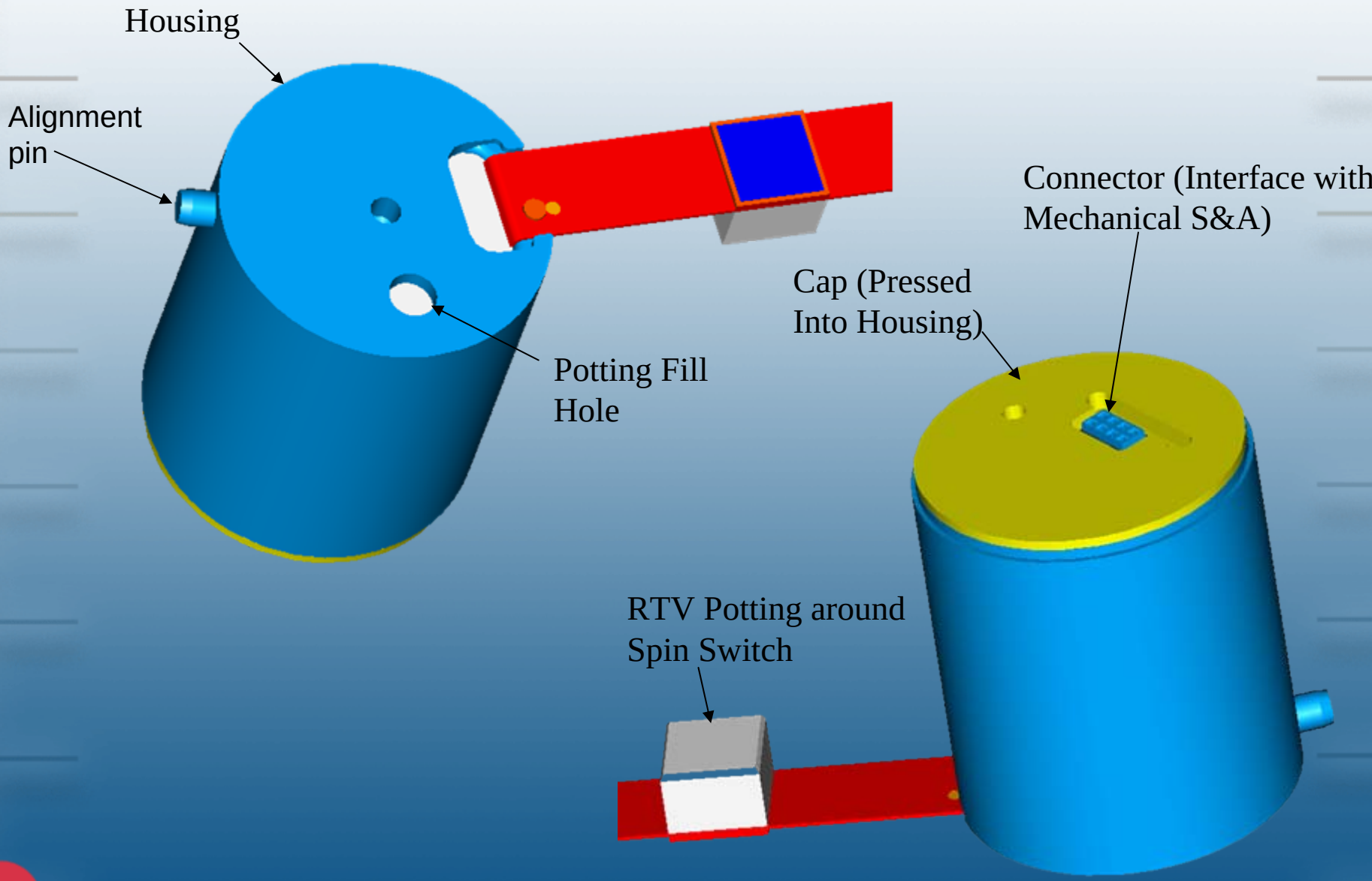
Safety Button

Piston Actuator

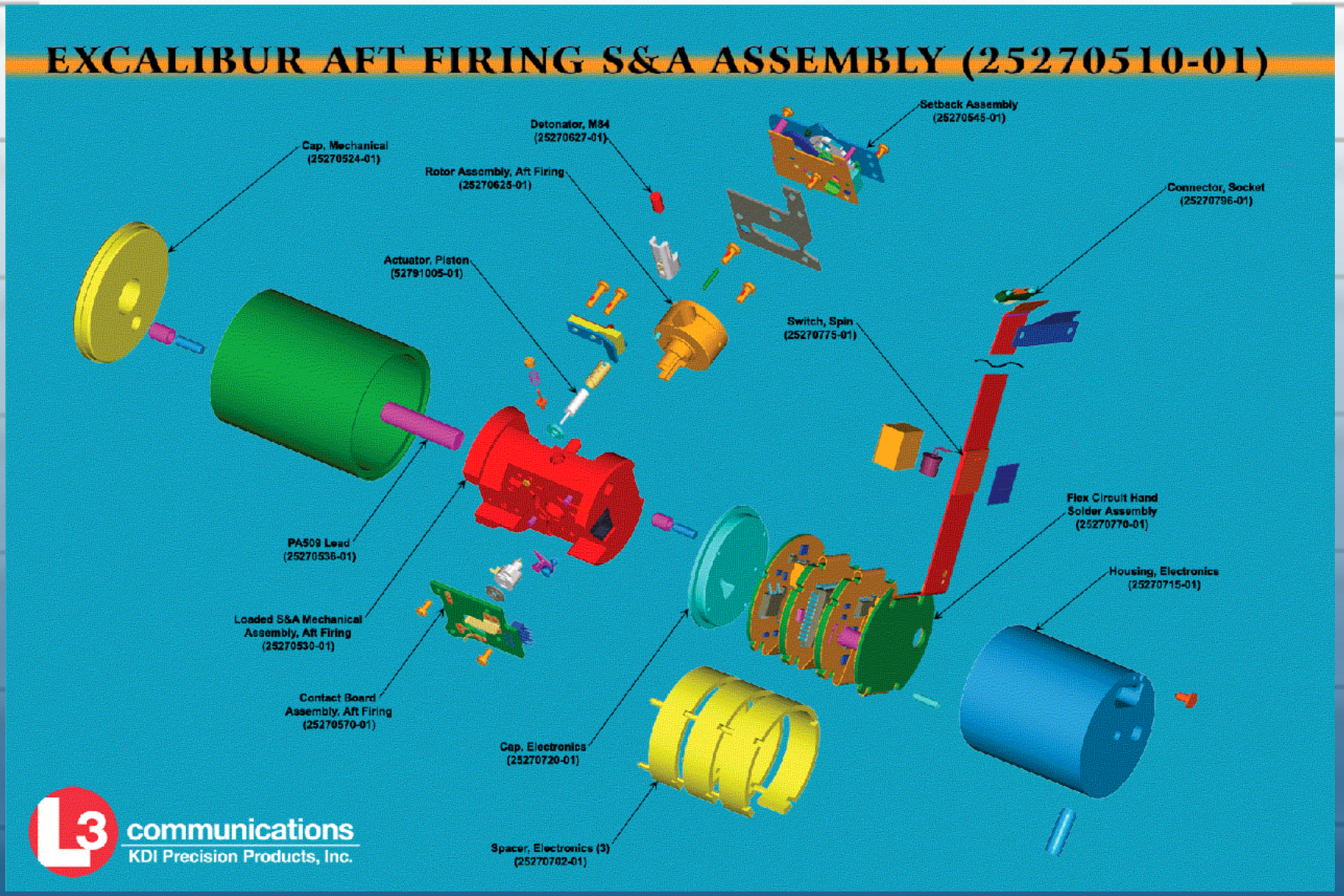
Excalibur Electronic Flex Assembly Module



Excalibur FSA Electronic Sub-Assembly

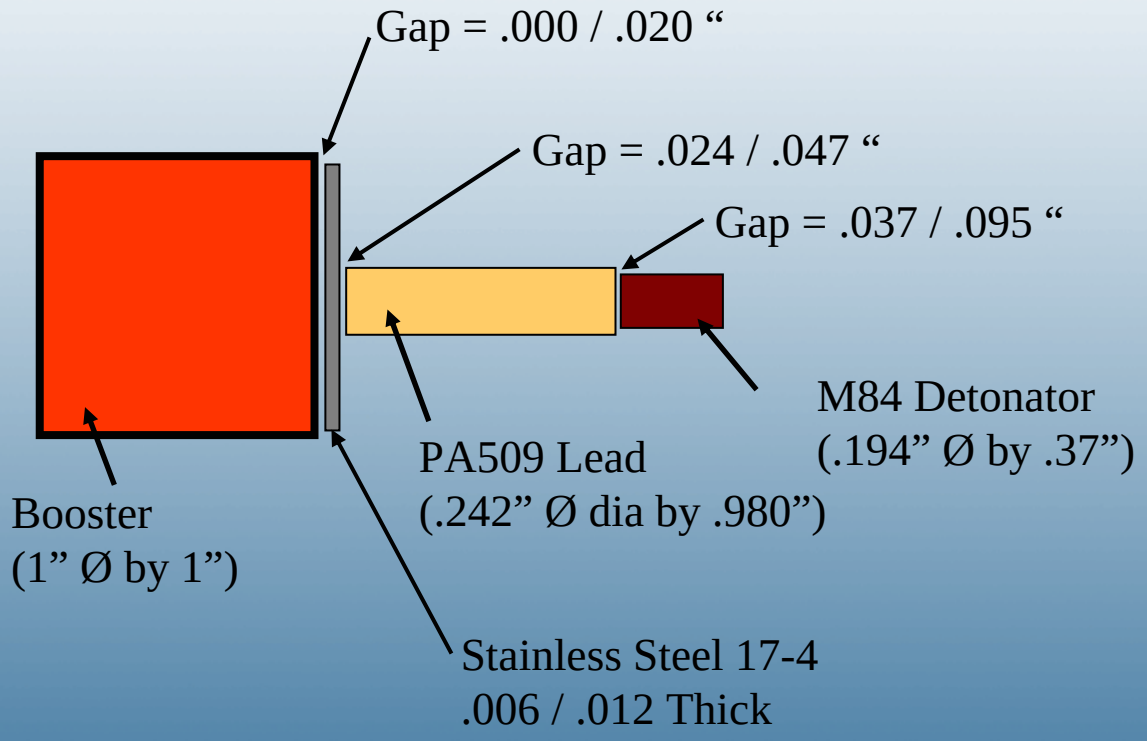


EXCALIBUR AFT FIRING S&A ASSEMBLY (25270510-01)

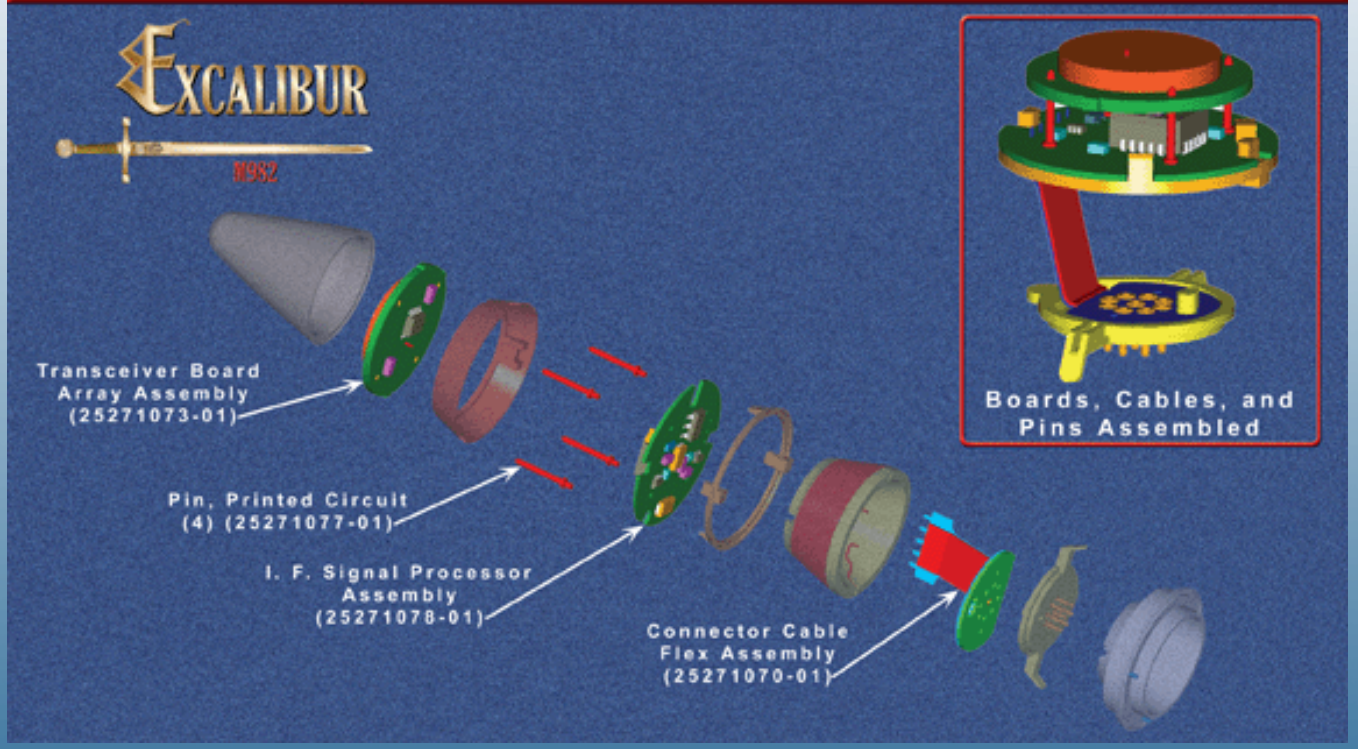


Excalibur FSA

Explosive Train



Excalibur
Height of Burst (HOB) Sensor
Module (25271000-01) Phase 2 – Qualification Configuration



- Production Fuze Prox Sensor Chipset
- Burst Height of 3.7 +/- 1 meters
- Point Detonate Backup
- Unpowered Until 3.5 Seconds from Target

FSA Design Summary

- Resulting Capabilities
  - Meets MIL-STD-1316D
  - Interactive W/ GN&C
  - Maximized Overhead Safety
    - Independent Timer
    - Arm Command issued Just Prior to Endgame
  - Excalibur was Fielded in May 2007 for Operation Use

ERGM

M982

S&A Program Milestones

- M982 (Excalibur) S&A
  - Completed Design Analysis, Design Verification Testing, Qualification, and AFSRB Certified
  - The Excalibur System was Fielded in May 2007 and is Currently in Operational Use
  - KDI is Under Contract to Develop a Low Cost ESAD Alternative S&A Design
- ERGM EX87 S&A
  - Finished DVT
  - ERGM has been terminated. The requirement for a guided extended range munition is still valid. NAVSEA is currently restructuring the program.

Excalibur ESAD Development

- Development team consisted of members from KDI, ARDEC fuze group at Picatinny and Adelphi
- Development program objectives accomplished
  - Drop-in replacement with existing S&A
  - Lower Unit Production Cost
  - Increased reliability
  - Hardware tests used to mitigate initial high risk areas
  - 1st Environment sensor designed, developed and tested
  - AFSRB informal and formal review completed
  - Preliminary Design Review completed
- Electrical and mechanical design completed
  - Functional hardware fabricated and tested
    - Explosive function test success
    - ARDEC airgun and railgun mechanical shock tests successfully completed (gun launch simulated)
    - EGLIN AFB howitzer hard target penetration tests successfully completed