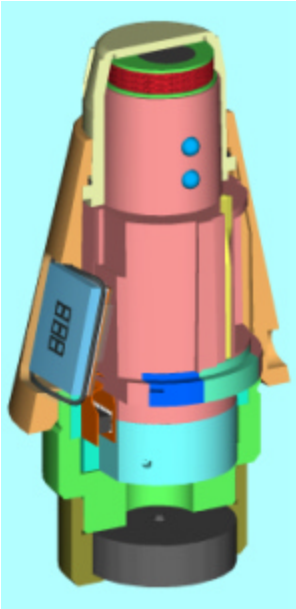
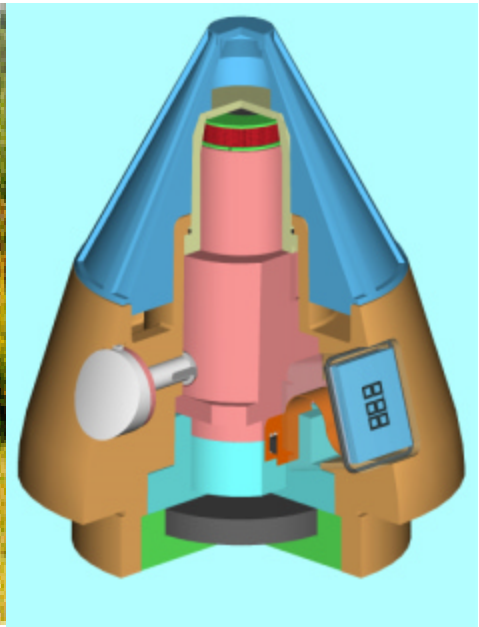
Electronic Time Fuze for Mortars (ETFM)





XM784/XM785 ETFM

Development Program

1 May 2002

Tony Pergolizzi
ARDEC Fuze Division

Dennis Ward
ARDEC Fuze Division

Marty Davis
Alliant Techsystems

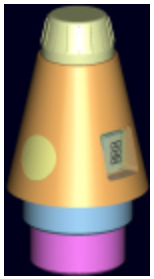
Alliant Techsystems has patents related to munitions hardware including patent number 5,693,906 which applies to the safe and arm mechanism and patent number 5,914,469 which applies to the snap dome switch in fuze applications.

Next Generation Mortar Time Fuze

ETFM Program Objective

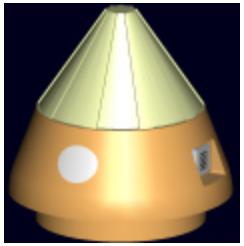
Develop mortar electronic time fuzes to replace the current mechanical time fuzes (M776 & M772) currently employed by the US Army on the 60 mm, 81mm and 120 mm illumination rounds and the 81 mm smoke round.

M776
(60mm & 120mm)

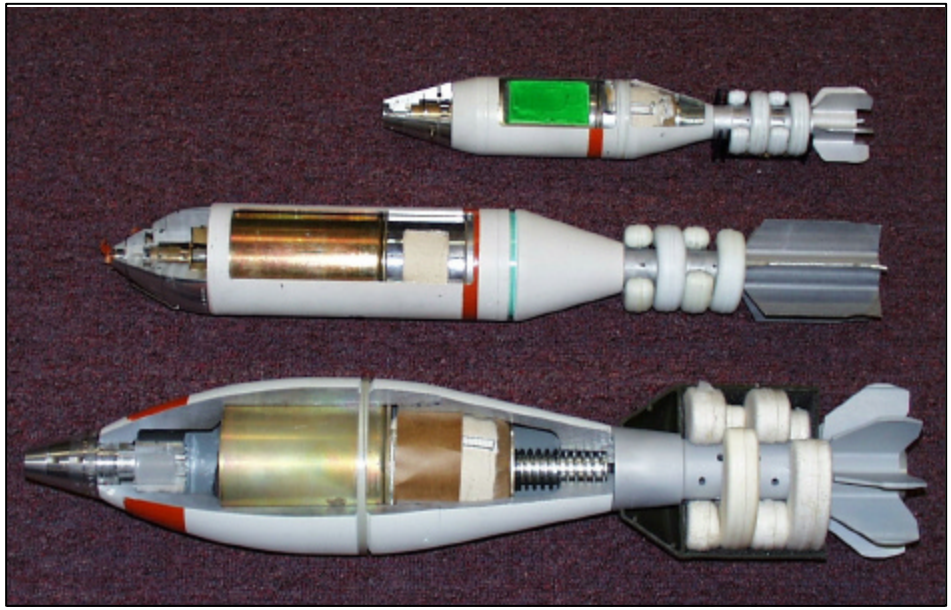


XM784

M772 (81mm)

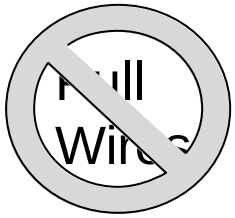


XM785



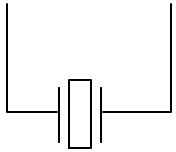
Why ETFM?

ETFM Provides:



•Elimination of pull wires w/new dual safe S&A

•Hand Settable w/o Tools - day and night setability w/back lit LCD



163.84KHz

•Enhanced time function accuracy w/Crystal time base

•Auto set capability w/inductive setting

•<u>Adaptability</u> – Design facilitates adaptation for cargo projectiles and other applications where overhead safety is required. (XM395, XM984)

Moving to a Three Fuze Family

Fielded	97	98	99	00	01	02	03	04	05

Proximity

M734 → → M734A1

Point Detonating & Delay

M745 → → M783

M935 →

Time

M772 →

M776/DM93 →

Mortar ET

User Payoff

- Go to War Fuze
- Increased Performance & Safety

- Training Fuze
- Over 90% Commonality with M734A1
- 1/2 the cost of M734A1

- Compliance w/current Army Safety Standards
- Replaces mechanical with electronic timing
- Increased performance
- CONUS production

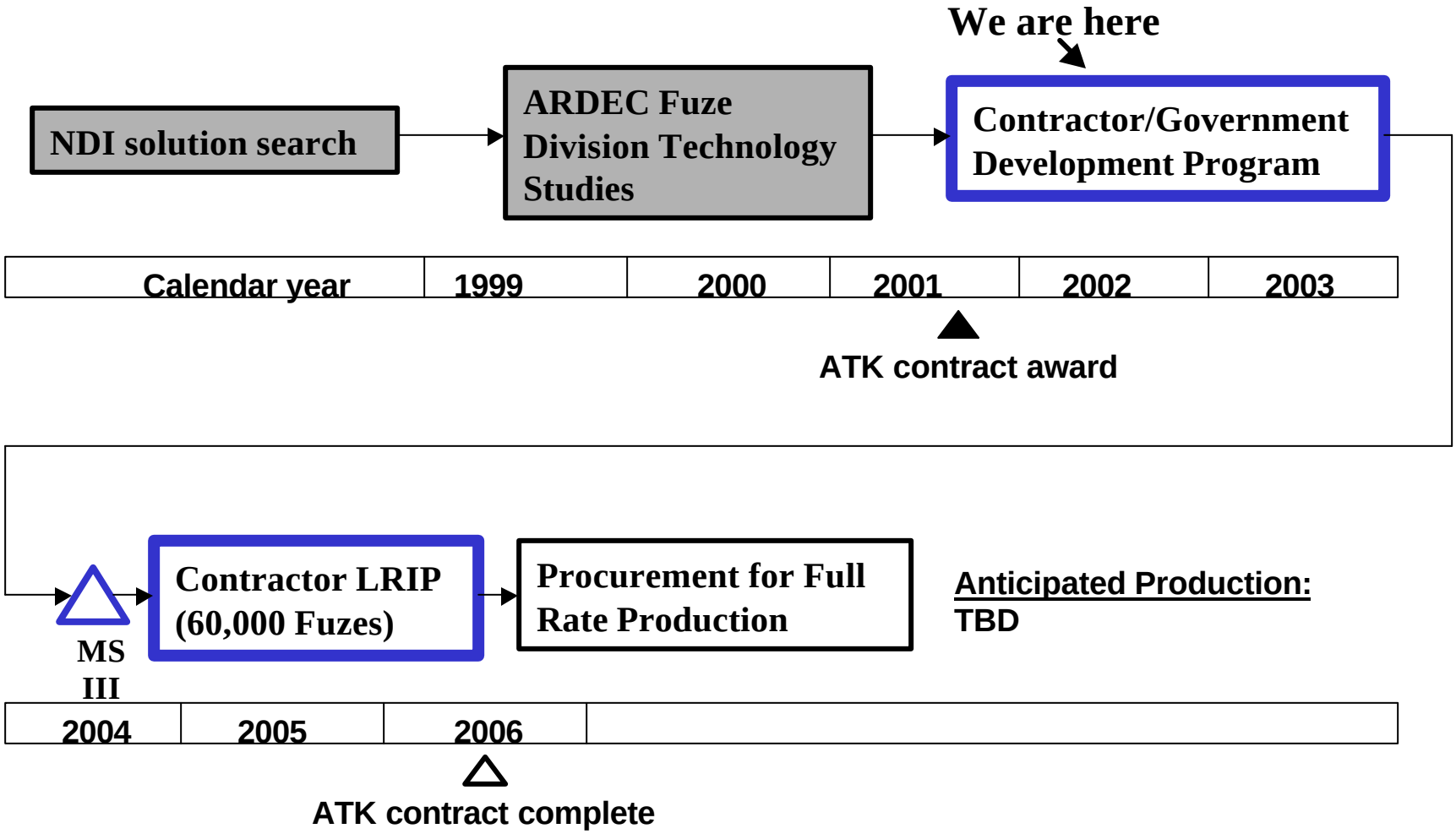
Effective Program Plan

ETFM Program Approach

- **Joint Government/Contractor program IPT**
  - US Army Infantry Center (USAIC), Fort Benning
  - PM Mortars
  - Army Fuze Management Office
  - ARDEC Fuze Division
    - -Picatinny
    - -Adelphi
  - Alliant Techsystems

- **Government Technology Studies**
- **ATK Engineering & Manufacturing Development**
  - Designed for Production
  - Production processes developed with design
  - Process control developed with process

Sound Procurement Strategy

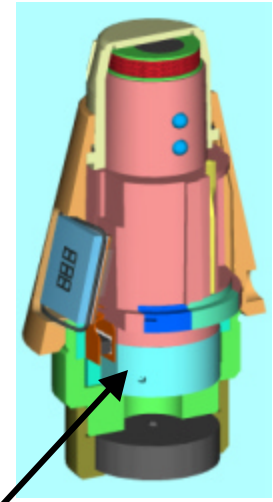


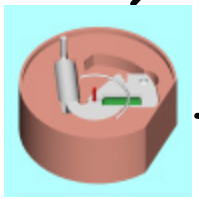
Fuze modernization with state-of-the-art technologies

ETFM Technologies

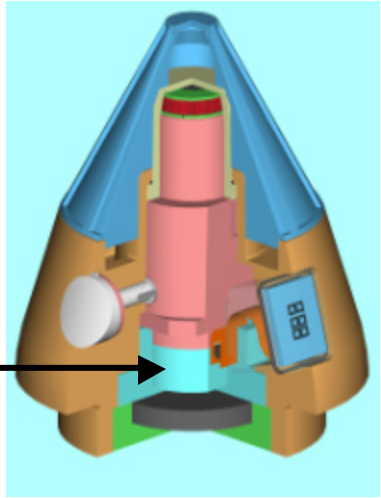
- Modular design approach - one fuze design fits both housings
- Commercial off the shelf (COTS) surface mount electronics
- Dual micro-controller electronic safety architecture
- Magnetic 2nd environment safety (Non-spin, non-air breathing application)
- Magnetic Sensor via dual usage of inductive set coil
- Lithium Thionyl Chloride reserve battery
- Miniaturized electromechanical command-to-arm S&A

Design capitalizes on lessons learned during the MOFA development program

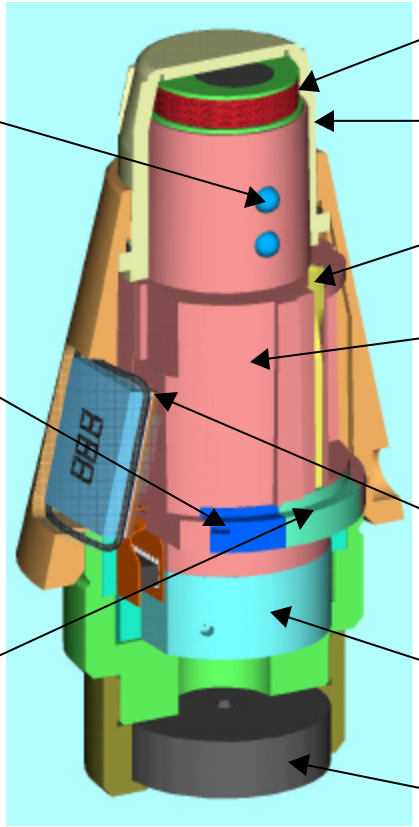


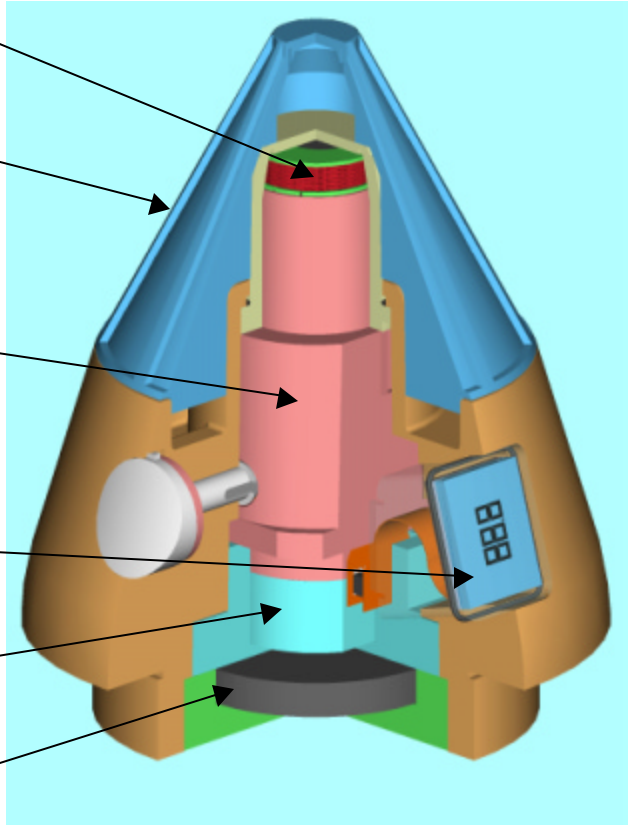


Safe & Arm



Modular Design
One Set of Modules Fits Both Housings





Increment / Decrement Switches

Battery Primer Assembly

Battery Stab Assembly

2nd Environment/ Inductive set coil

Setting ring

Battery Stab Rod

Potted Electronics Assembly

Back-lit LCD

S&A

*Expulsion Charge

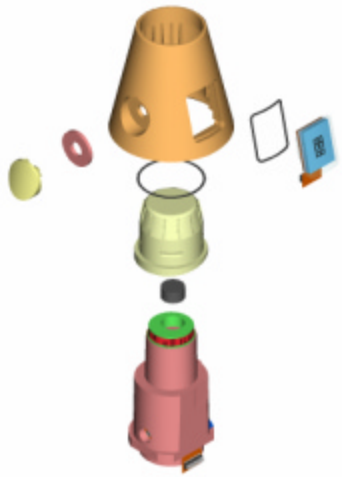
XM784

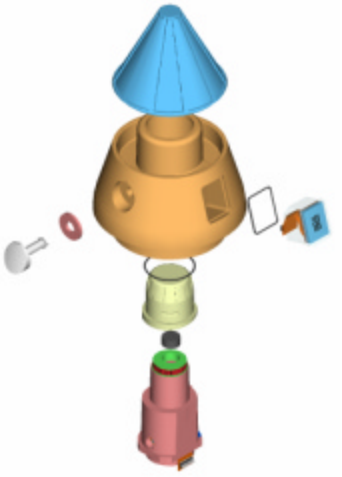
XM785

*not common

Modular Design Provides Flexibility

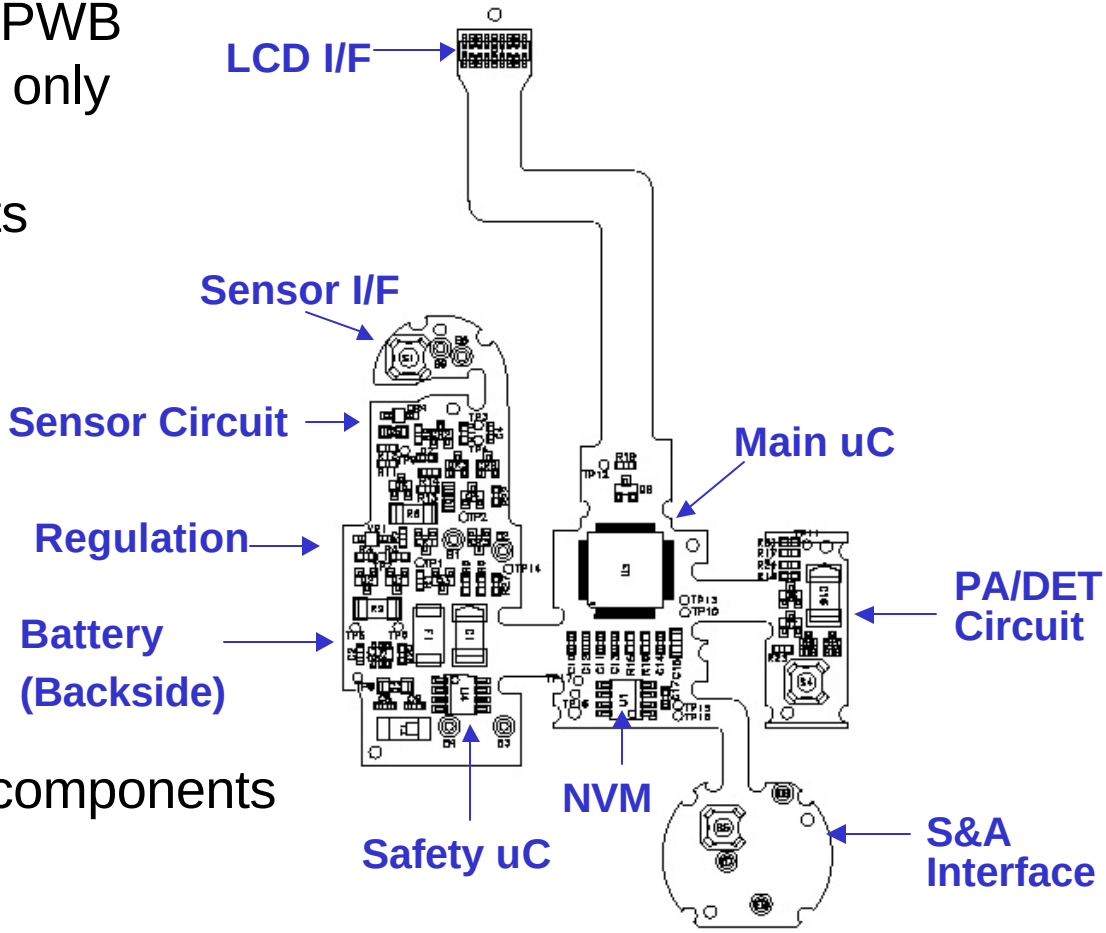
- **Easy to Assemble**
- **Platform for Growth**
  - Adaptable to cargo projectile (Overhead Safety)
  - Command-to-arm S&A applications
    - -Expulsion charge
    - -HE initiation
    - -Rocket motor initiation
  - Magnetic 2nd environment sensor applications
    - -Non-spin
    - -Non air breathing
- **Facilitates Change**
  - Adaptable to embedded fuze applications
  - Add performance enhancements
    - -Velocity measurement
    - -Turns counting





COTS technology - highly cost effective

- 2-Layered Stiffened Flex PWB
  - -Top-side components only
  - -Back side stiffener
  - -Minimize interconnects
  - -Easy to package



- Standard surface mount components
  - -No hand soldering
  - -No ASIC's
  - -SMT connectors

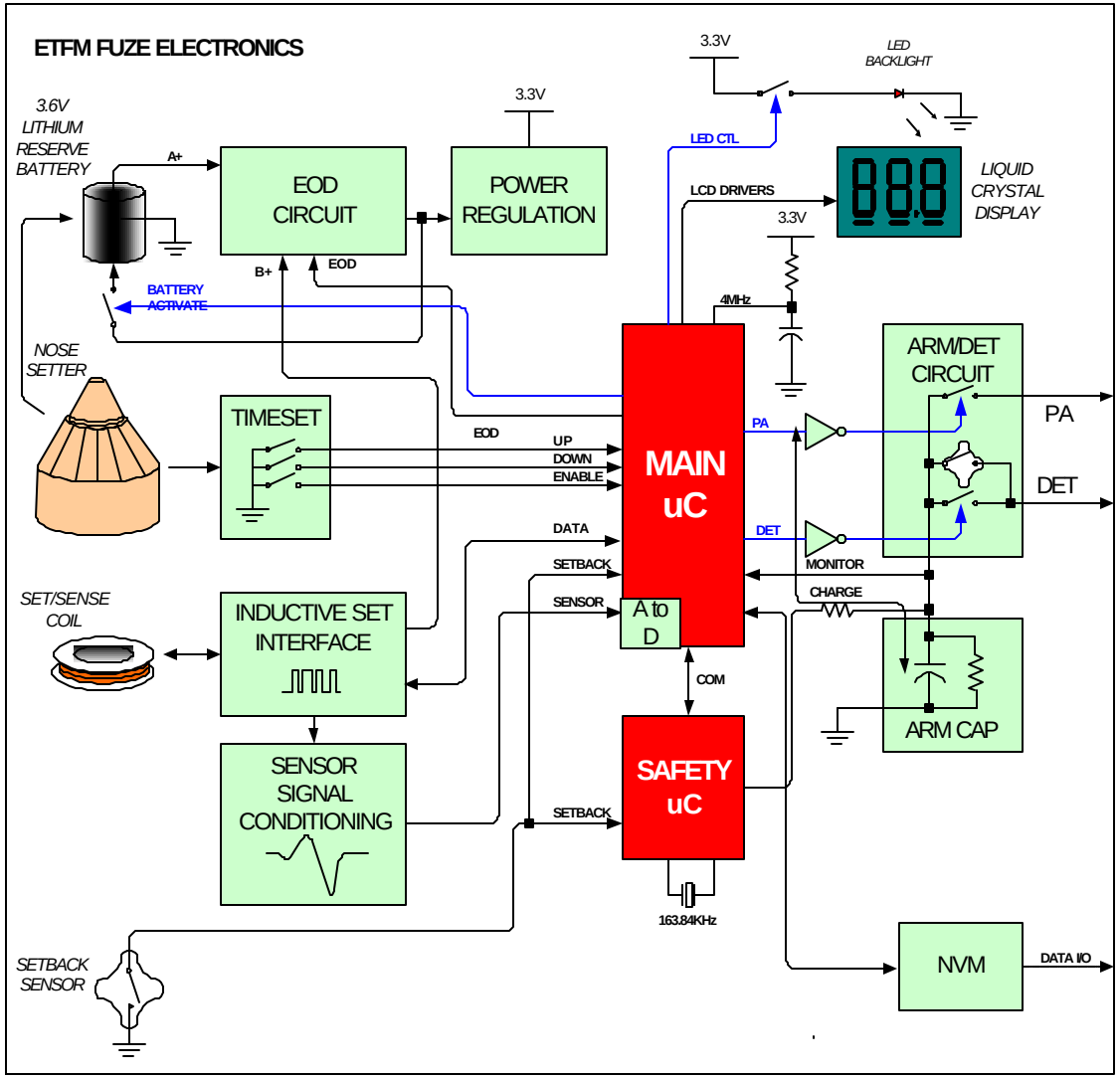
Dual Micro-controllers ensure safety

Main Micro

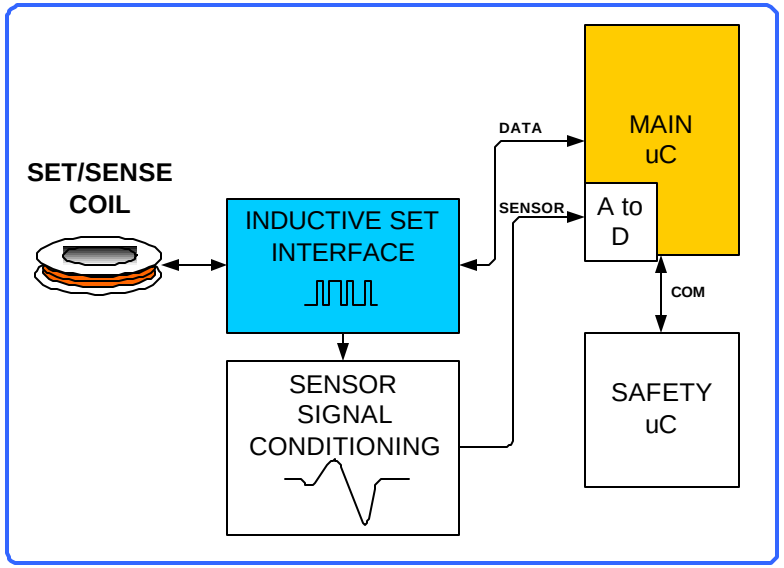
- Battery Primer Initiator
- Setback Sense input
- 2nd Enviro Sig Process
- Bi-directional Comm Link
- A/D inputs
- Inductive Time Set I/O
- Manual Time Set I/O
- LCD Backlight Control
- ARM & FIRE control
- EOD control

Safety Micro

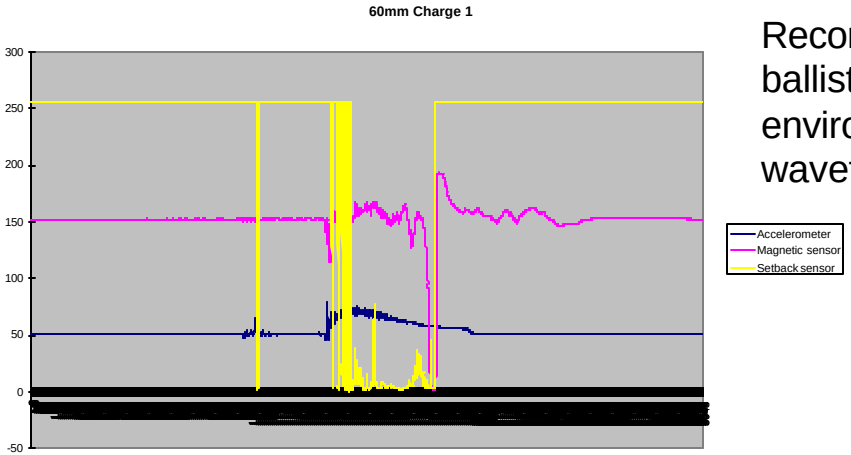
- Setback Sense input
- 2nd Enviro Sig Process
- Bi-directional Comm Link
- Fire Capacitor charging



Innovative magnetic sensor for non-spin second environment safety

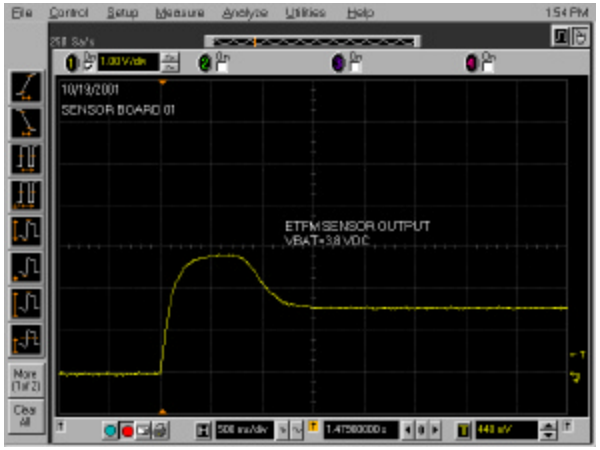


- Tube Exit Signature Sensor
  - Standard magnetic coil
  - AC gain = 40
  - Over sampling 8-bit A/D (52uS sample rate)
- Sensor Characterization
  - Tube signature data collection
  - Ballistic characterization (on-board-recorder)

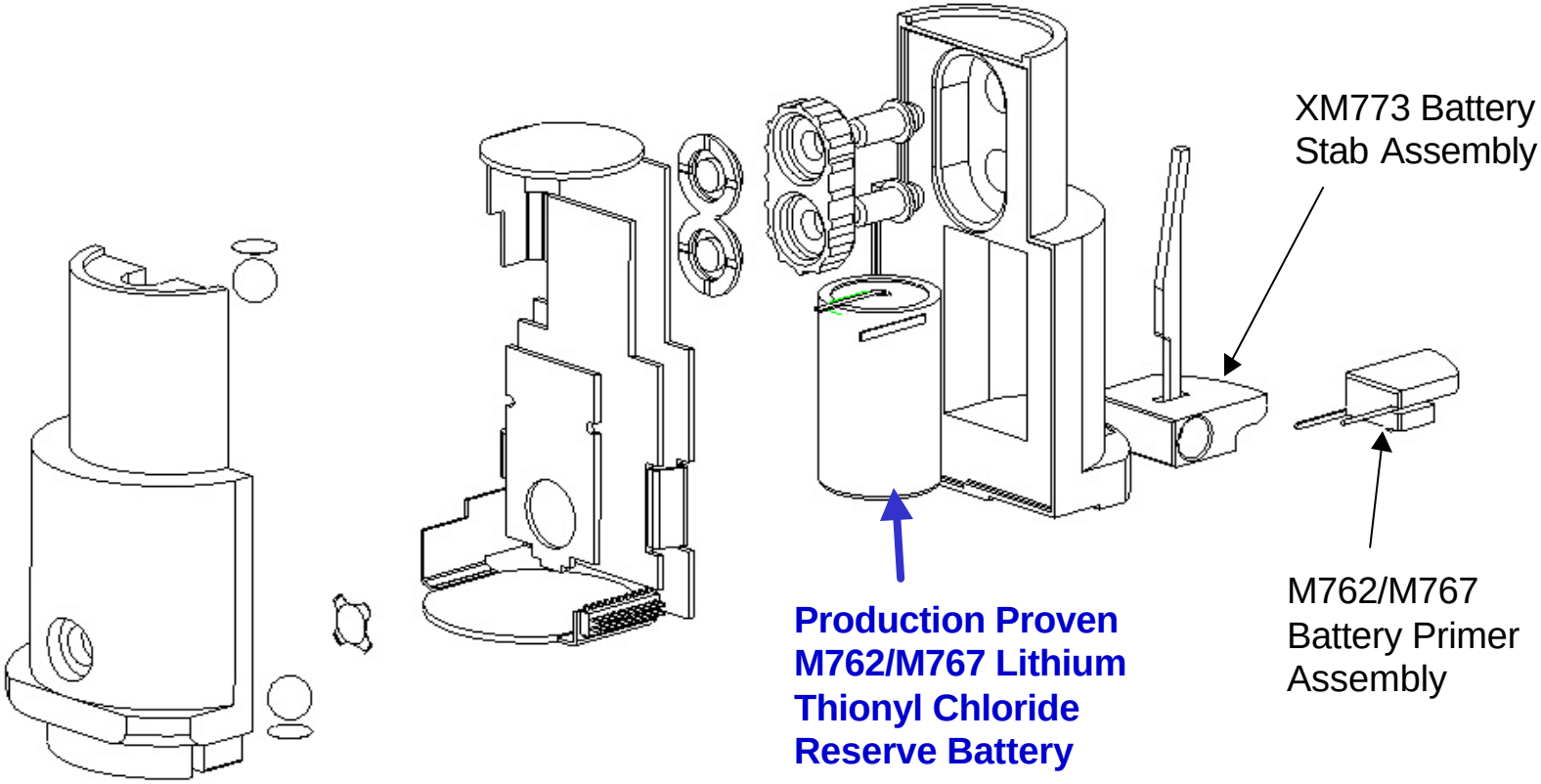


Recorded ballistic environment waveforms

Circuit Start-up Characteristics

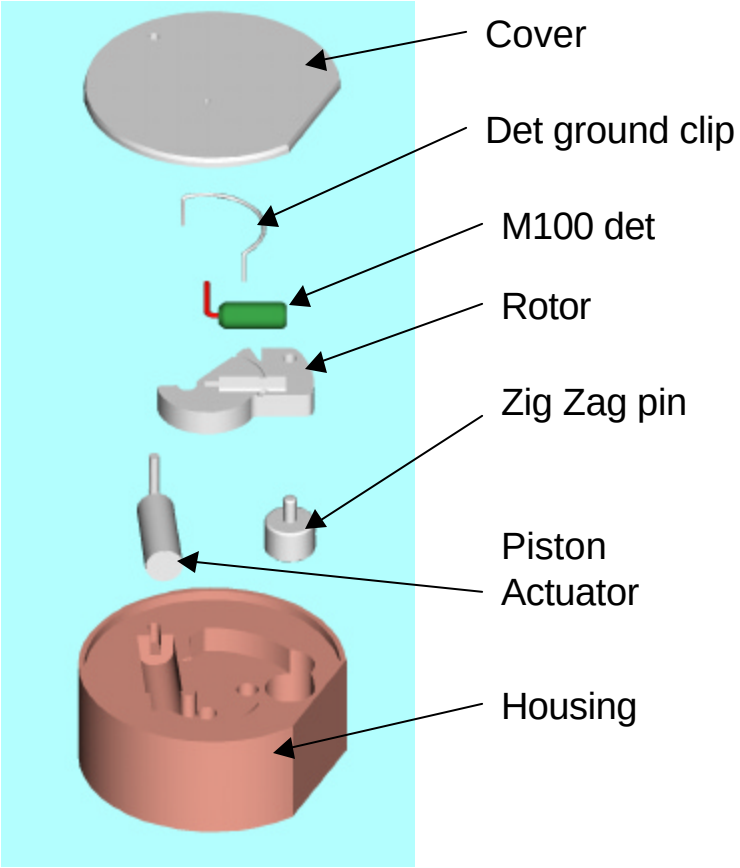


Low risk power source

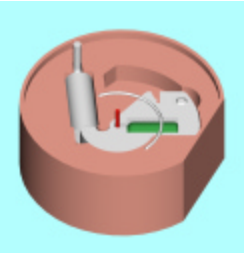


Application flexibility provided via miniature command-to-arm S&A

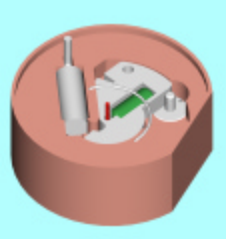
- Fixed Arm time (determined by electronics)
- Explosive train flexibility
  - -Expulsion charge
  - -High Explosives
  - -Rocket motor
- Over head safety achievable



S&A exploded view



Safe

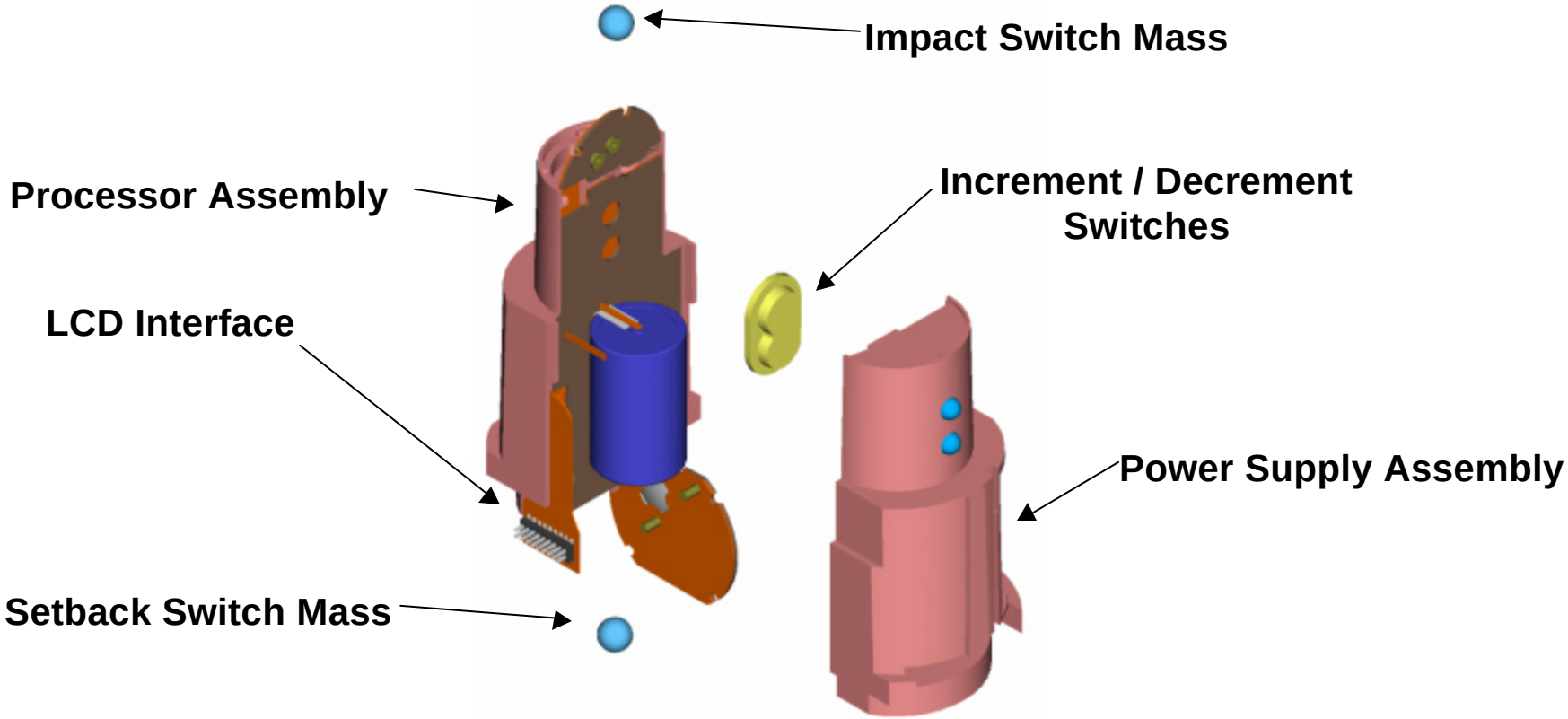


Armed

ATK S&A Patent Pending

Designed for Production

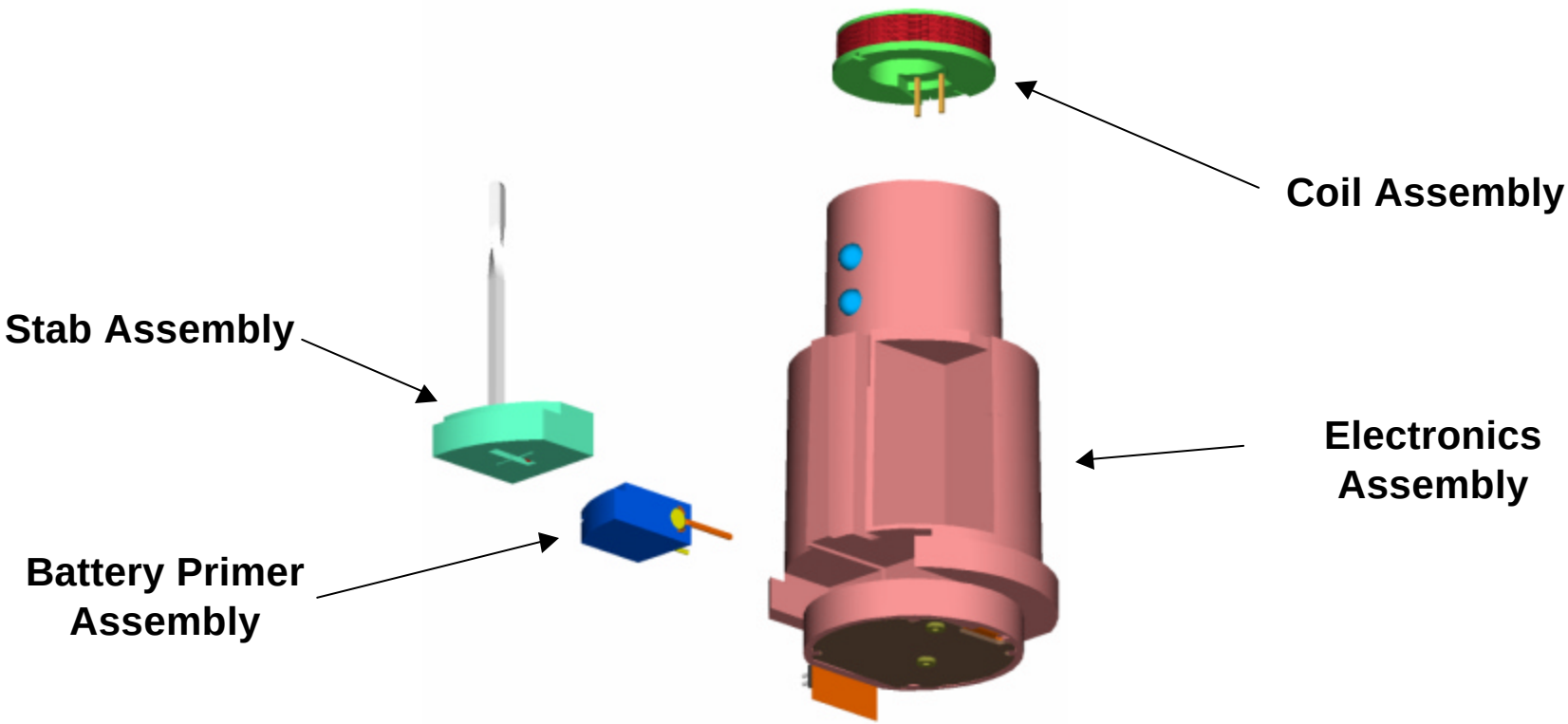
Electronics Assembly



- The Processor and Power Supply assemblies are ultrasonically welded together and then potted with polystyrene.

Designed for Production

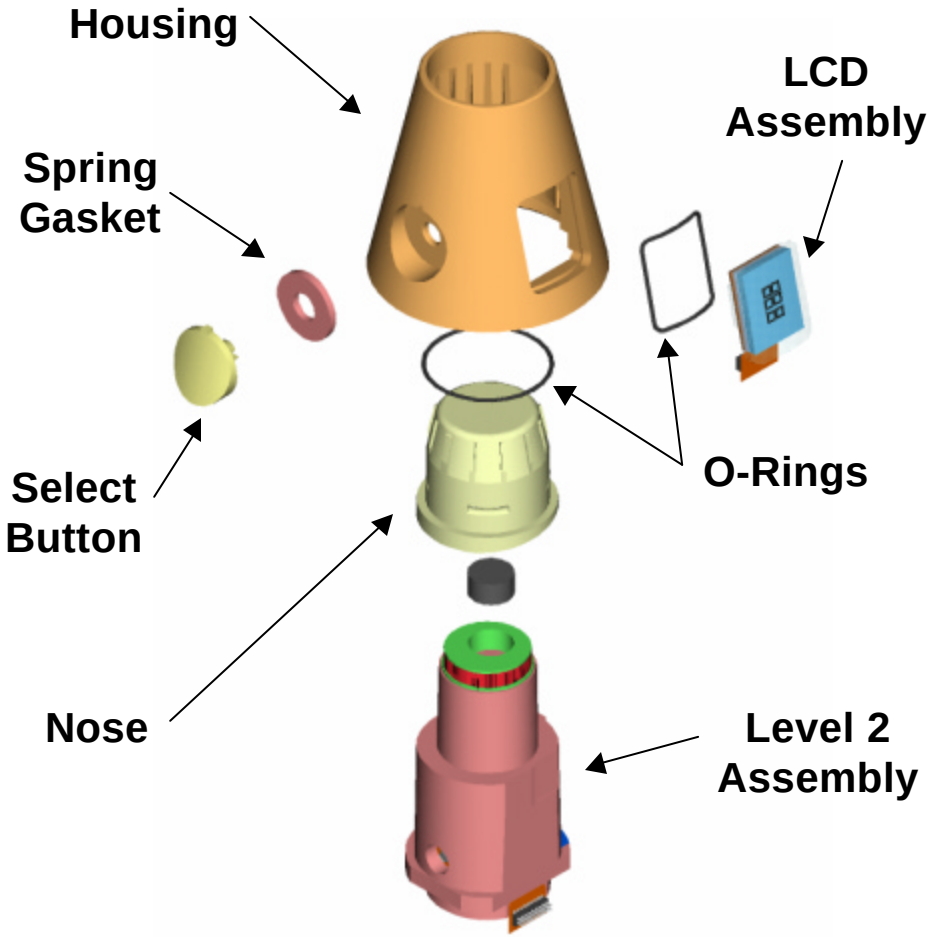
Level 2 Assembly



- The Coil Assembly & Battery Primer Assembly contacts interface with sockets in the CCA.

Designed for Production

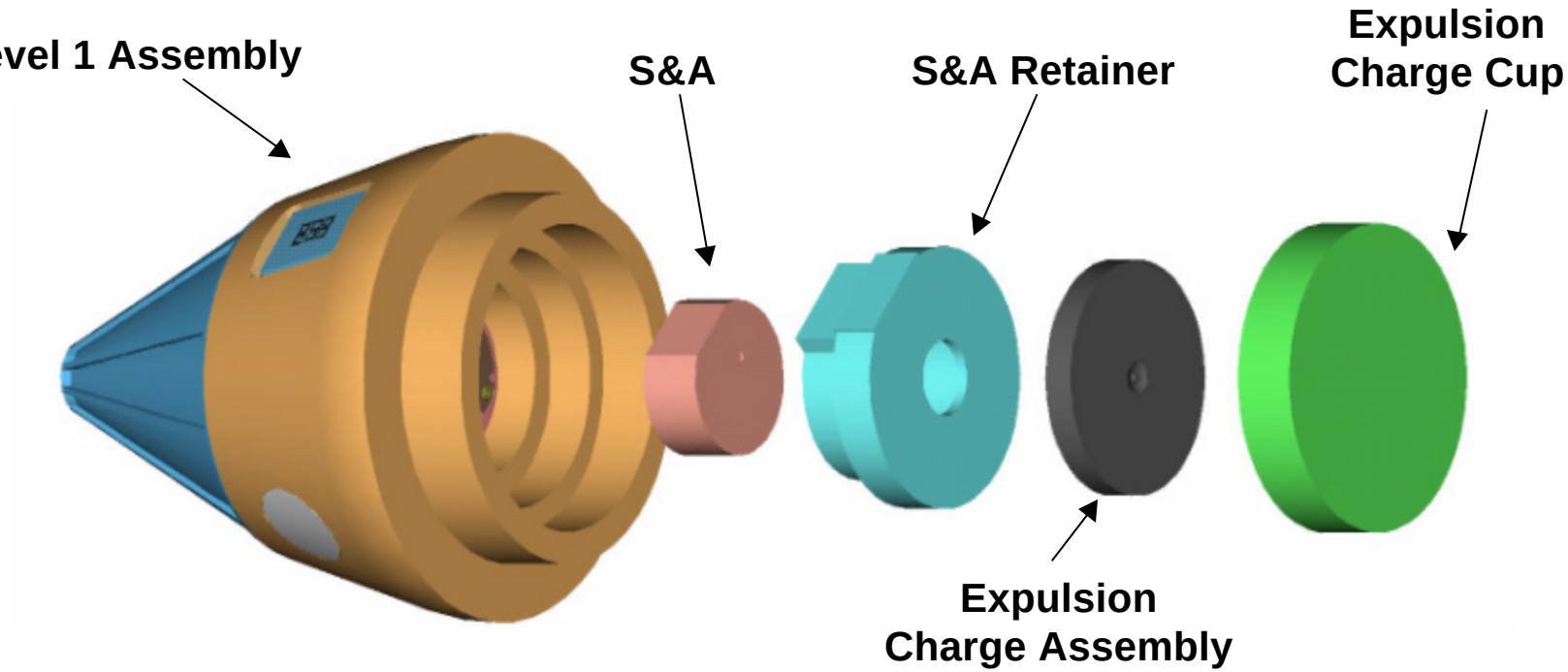
Level 1 Assembly, XM784



- LCD Assembly snaps into Housing.
- Nose & O-Ring slide over Level 2 Assembly and this assembly inserts into the Housing.
- The Spring Gasket is placed on the Select Button. Then Select Button snaps into Housing

Designed for Production

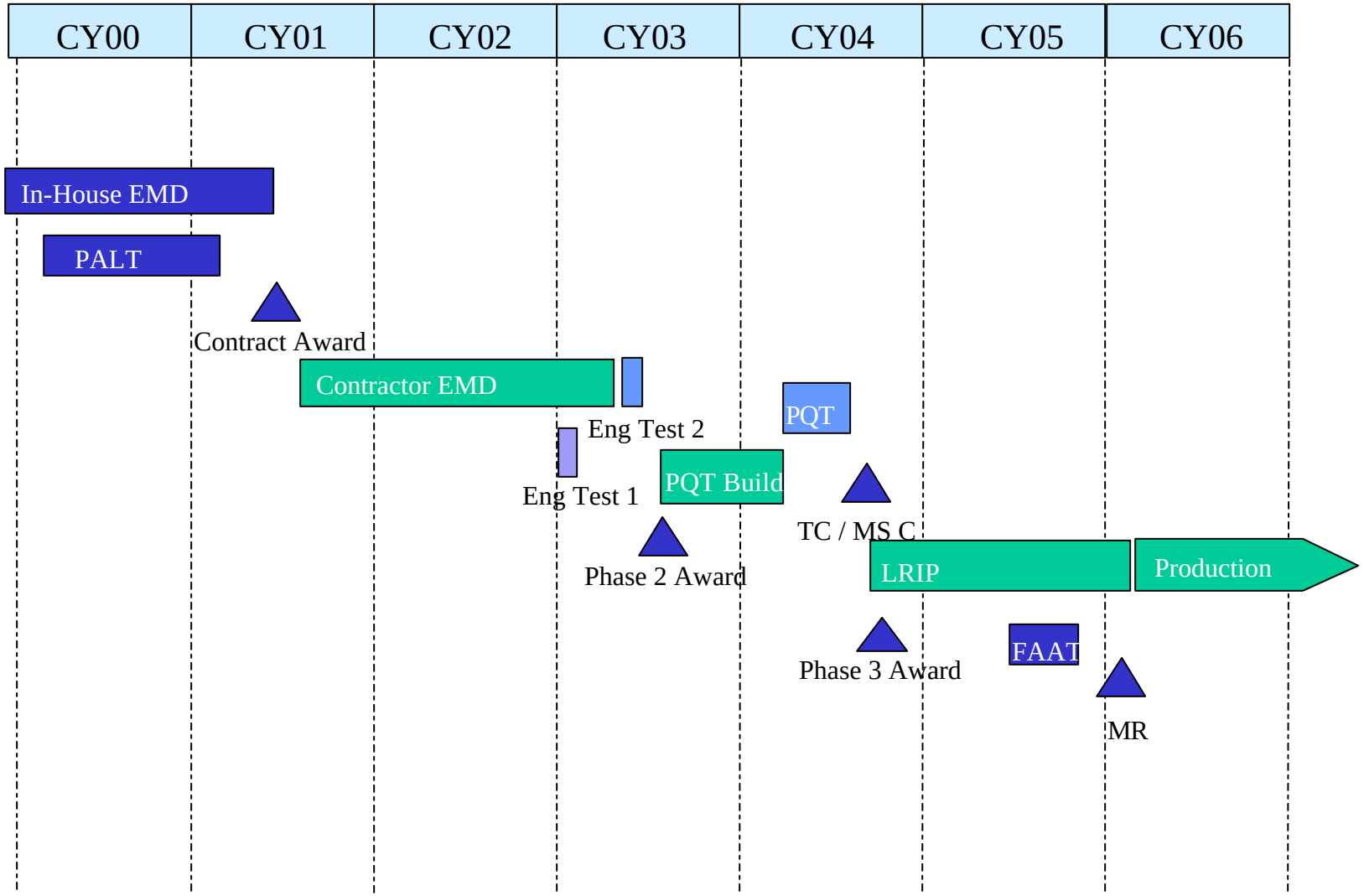
Final Fuze Assembly, XM785

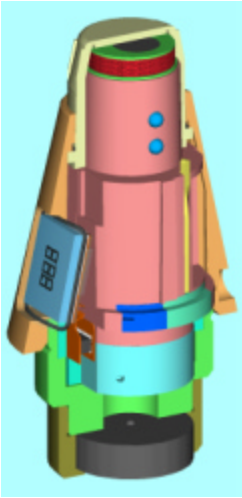
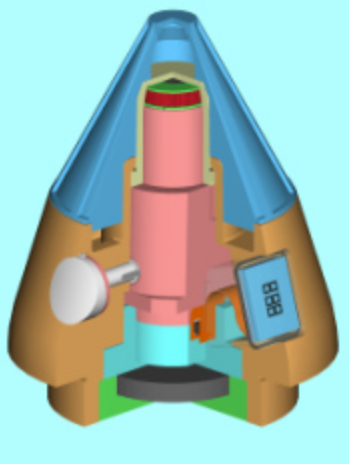


- The S&A, S&A Retainer, LCD Connector Support, and Expulsion Charge Assembly are supported within the Level 1 Assembly by the Expulsion Charge Cup.

XM784/ XM785 ET Fuze for Mortars

Schedule



KEY USER BENEFITS

- **Operational Flexibility**
  - Manually settable day or night <u>without tools</u>
  - Inductively auto settable
- **Improved Performance**
  - Meets all MIL-STD-1316E safety requirements
  - Supports future mortar fire control systems
  - Achieves Increased time function accuracy
- **Value For The Dollar**
  - Platform for growth (Adaptability)
  - Designed for producibility
  - Up-to-date technologies