40mm High Explosive Multi-Mode (HEMM) Grenade Concepts

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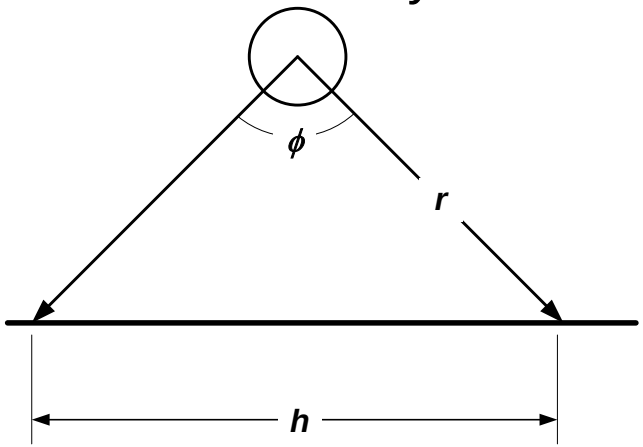
Briefing Objective

- Project Overview
  - Background
  - Scope
  - Objectives
  - Approach
  - Results

Background & Scope

- Background
  - There is a need to more effectively defeat enemies in defilade



  - The lethality of grenades can be increased by launching more, most, or all fragments in a preferred direction – at the target
- Scope
  - Phase I was an iterative design and modeling effort
    - Establish baseline performance of working munitions
    - Compare effectiveness of 40mm directed fragmentation munition concepts

Technical Approach

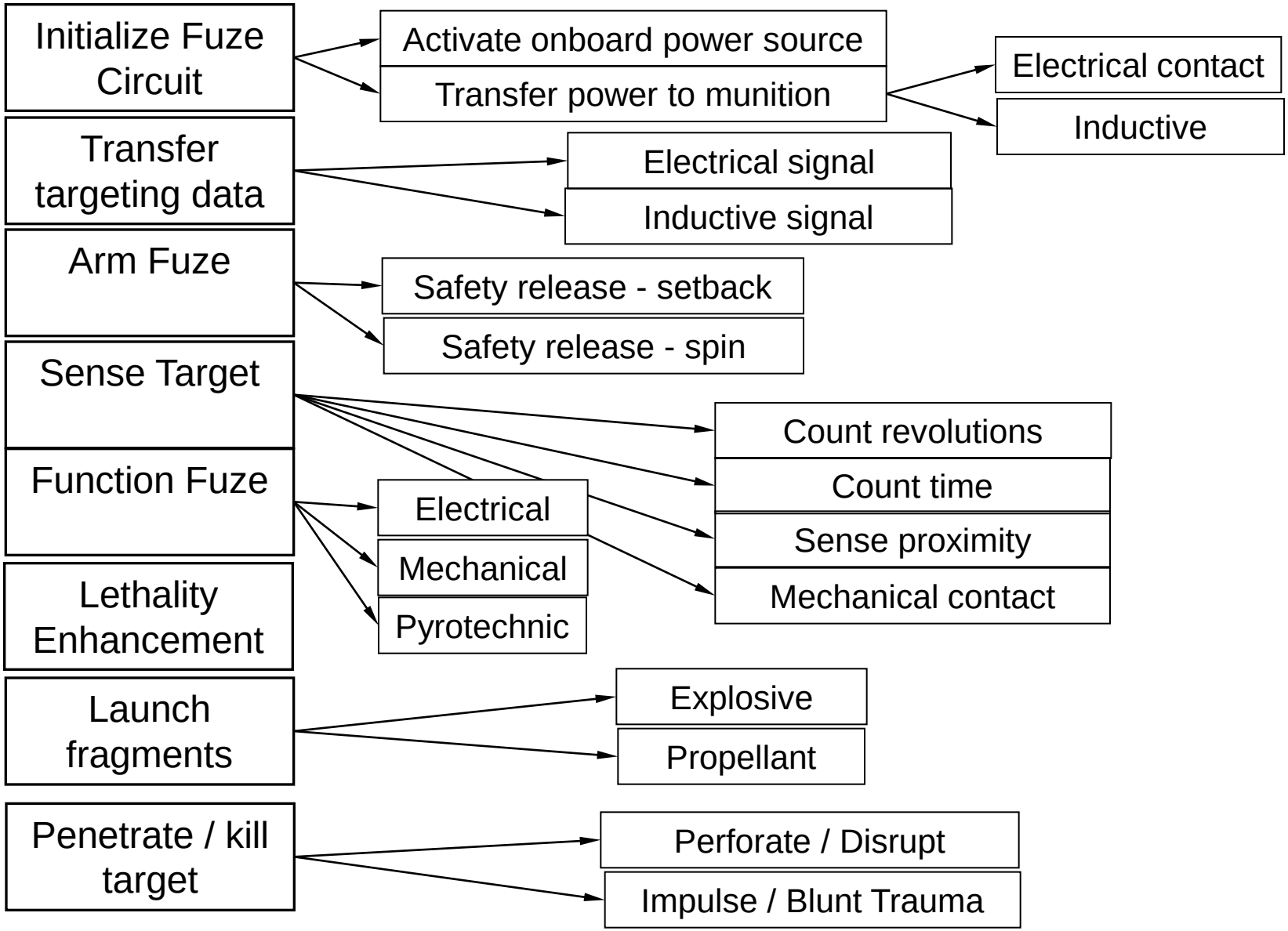
- Requirements & Constraints Development
  - Establish applicable performance requirements: start with the effects on target and work backwards
- Preliminary Concept Development
  - Two design teams
  - Iterative concept development & analyses
- Fuzing Design Development
- Preliminary Design Verification
  - Limited detail of modeling & analyses
- Further Concept Development
  - Refine definition of subsystems & components
- Performance Verification of Concepts
  - Verify design in virtual environment

Functional Analysis

- Eight fundamental functions are basis of concepts
  - **Initialize Fuze Logic Circuit**
  - **Transfer Targeting Data**
  - **Arm Fuze**
  - **Sense Target**
  - **Function Fuze**
  - Lethality Enhancement Method
  - Launch Fragments
  - Penetrate/Kill Target

Fuze-related functions

Function Methods

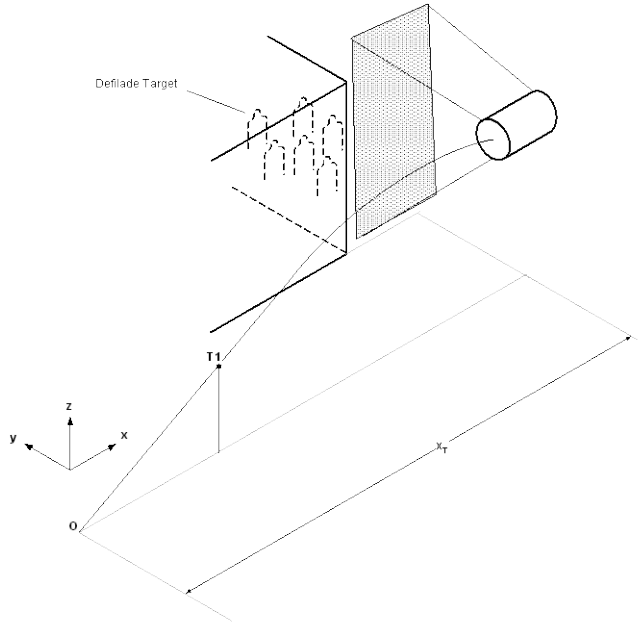


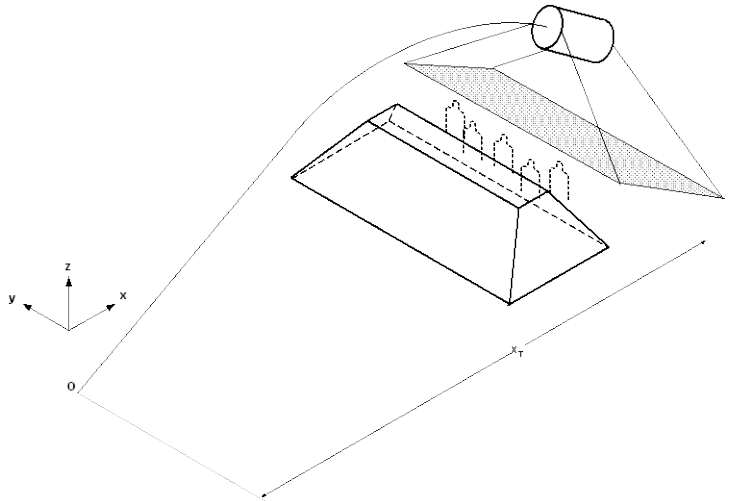
Lethality Enhancement Methods

- Time or Orientation
  - Control time or orientation at which selected portions of munition detonate
- Reconfigure Munition
  - Statically or dynamically rearrange munition configuration so most or all of fragments are projected in a preferred direction
- Submunitions
  - Deploy then detonate submunition(s) at appropriate times
- Redistribute Mass of Baseline Munition
  - Redistribute mass of baseline munition to increase number of radial fragments
- Mixed Fragment Masses/Types
  - Large number of small fragments
  - Limited number of massive fragments (more penetrating capability)
    - Preformed, controlled (scoring/notching), EFPs

Operational Modes

- Directed fragmentation
  - Shooter designates direction of fragments

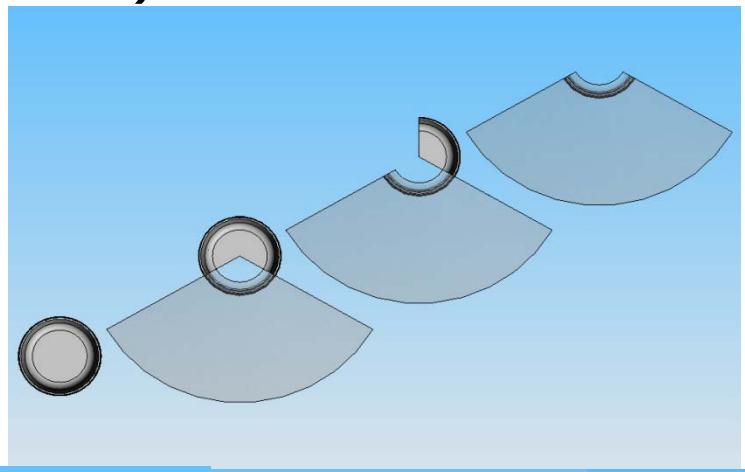


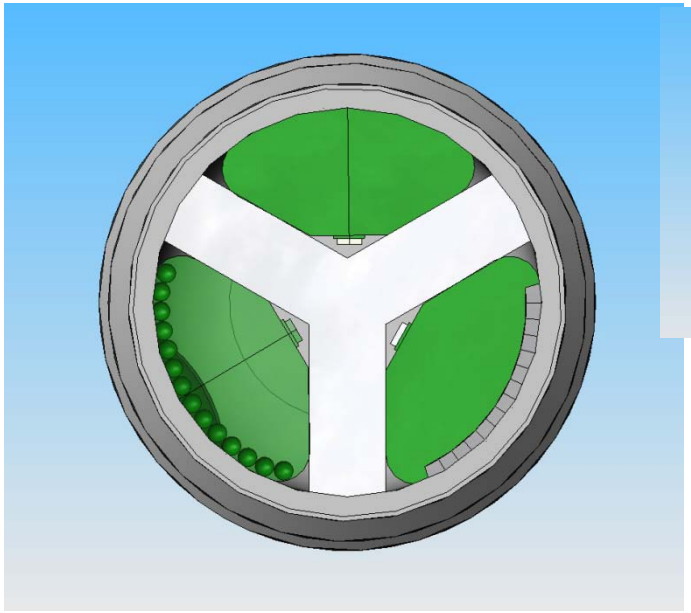


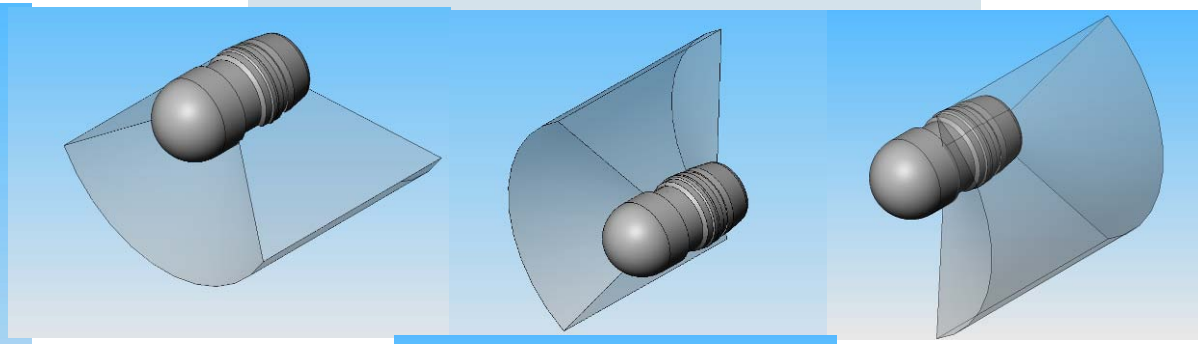
- Axisymmetric burst
  - Burst on contact
  - Airburst
- Anti-armor mode

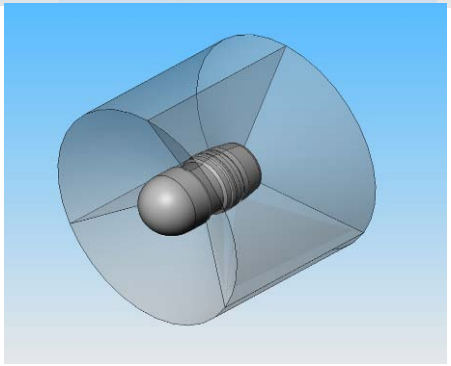
Initial Concepts (1 of 2)

- Sequential Segment Detonation



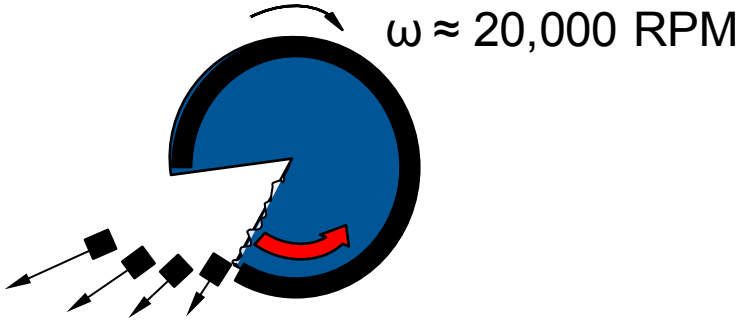




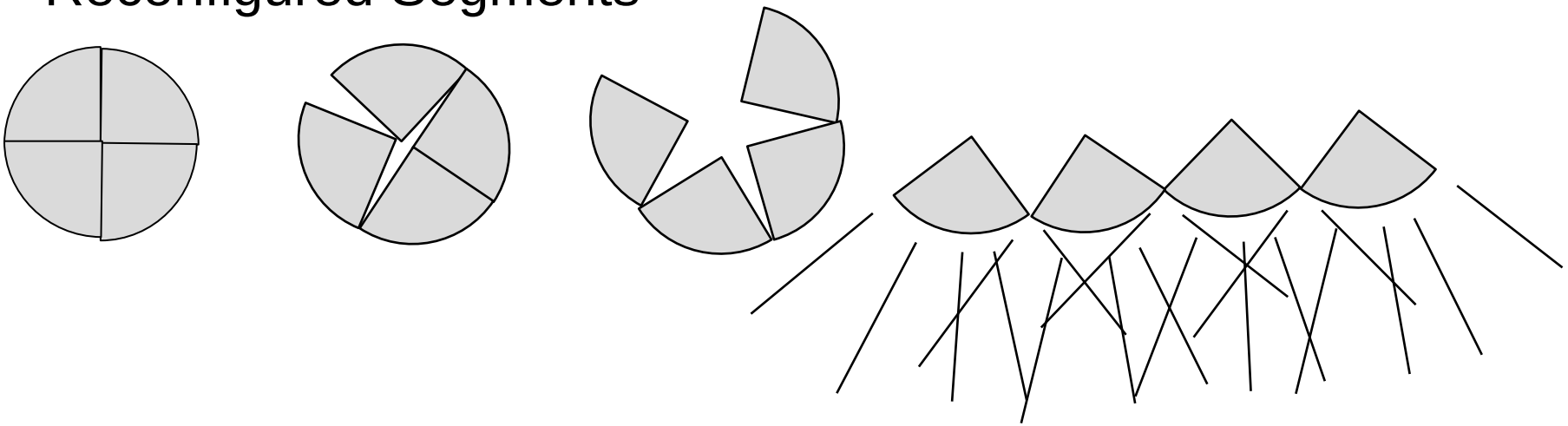


Initial Concepts (2 of 2)

- Counter-rotating Detonation Wave



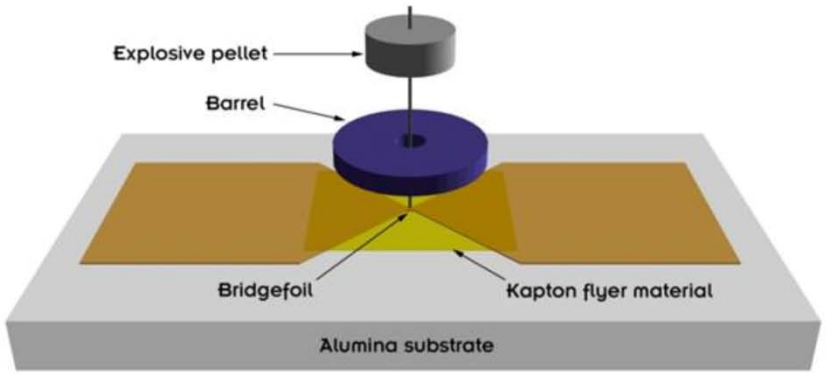
- Reconfigured Segments



EFI-Based Fuzing

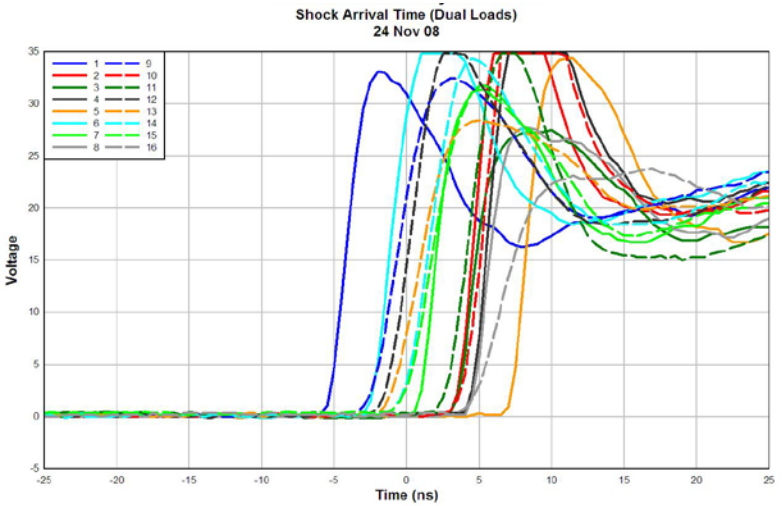
All of the 40mm DFM concepts use EFI-based electronic firing set for multi-functionality, timing precision, and safety

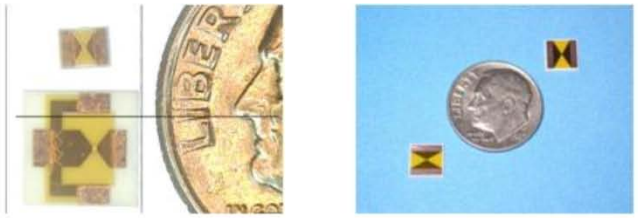
Initiator	Current	Voltage	Energy	Power	Time	Remarks
Hot Wire	1A	20V	0.2 J	1 W	1 ms	Initiator to sensitive primary to sensitive secondary explosive
EFI	2000A	1000V	0.2 J	3 MW	1µs	Initiator to insensitive secondary explosive



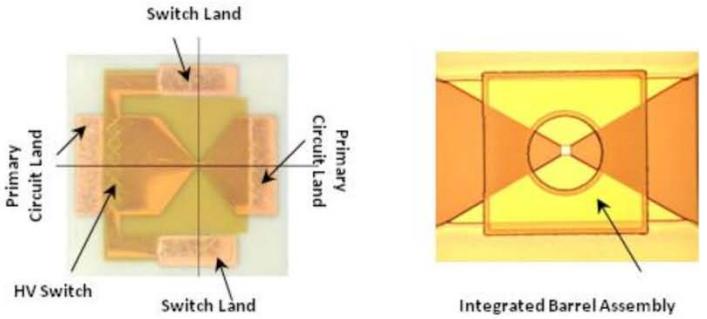
Basic EFI Configuration

Exploding Foil Initiator (EFI)



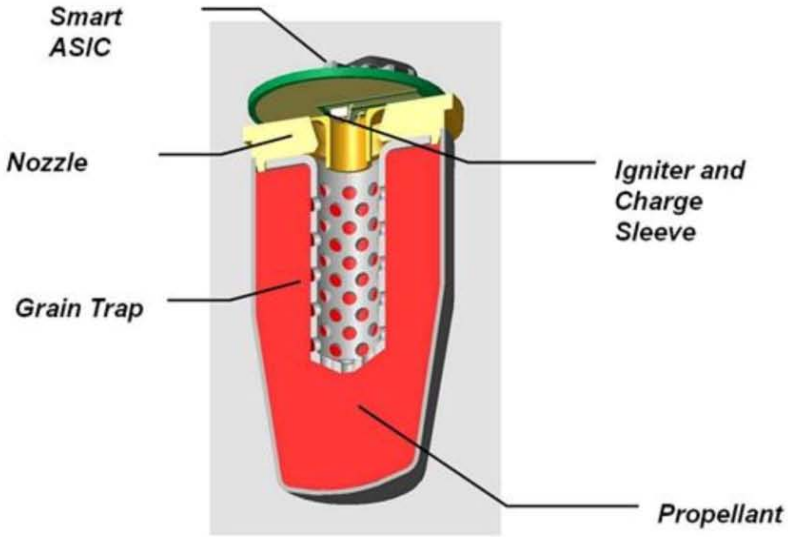


Fabricated EFI of Various Sizes and Types



Battelle fabricated EFIs

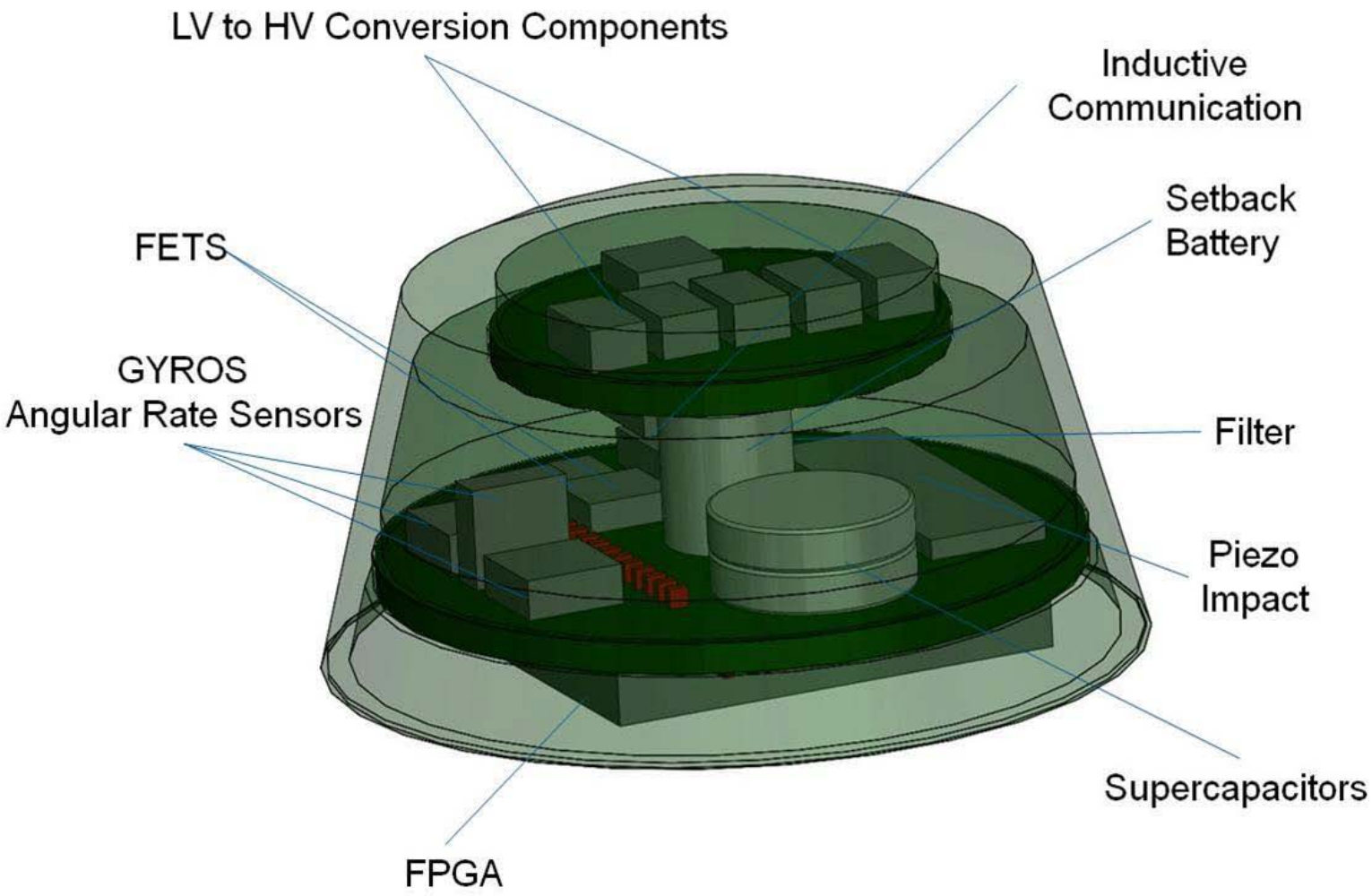
Deployment Charge COTS Item



SEA Smart Thruster

SEA Printed Circuit Board Sizing

Fuze Packaging Concept



Summary

- **40mm High-Explosive Multi-Mode Grenades are Feasible**
- Greater lethality
  - In anti-personnel mode: most fragments can be directed at targets in defilade
  - In anti-armor mode: standoff can be increased to optimize shaped charge penetration
- Substantially more reliable performance
  - Ensured through the use of an electronic S&A subsystem
- Lower development costs
  - COTS or COTS-adaptable electronics avoid substantial development time and cost
- Retention of legacy capabilities
  - Multi-mode grenades can be employed the same as current grenades
- Design growth potential
  - Inherent programmability can adapt to emerging needs
  - Tactics can be evolved to take advantage of additional modes of operation

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