Future Requirements of Enhanced Energetics for Decisive Munitions – F.R.E.E.D.M

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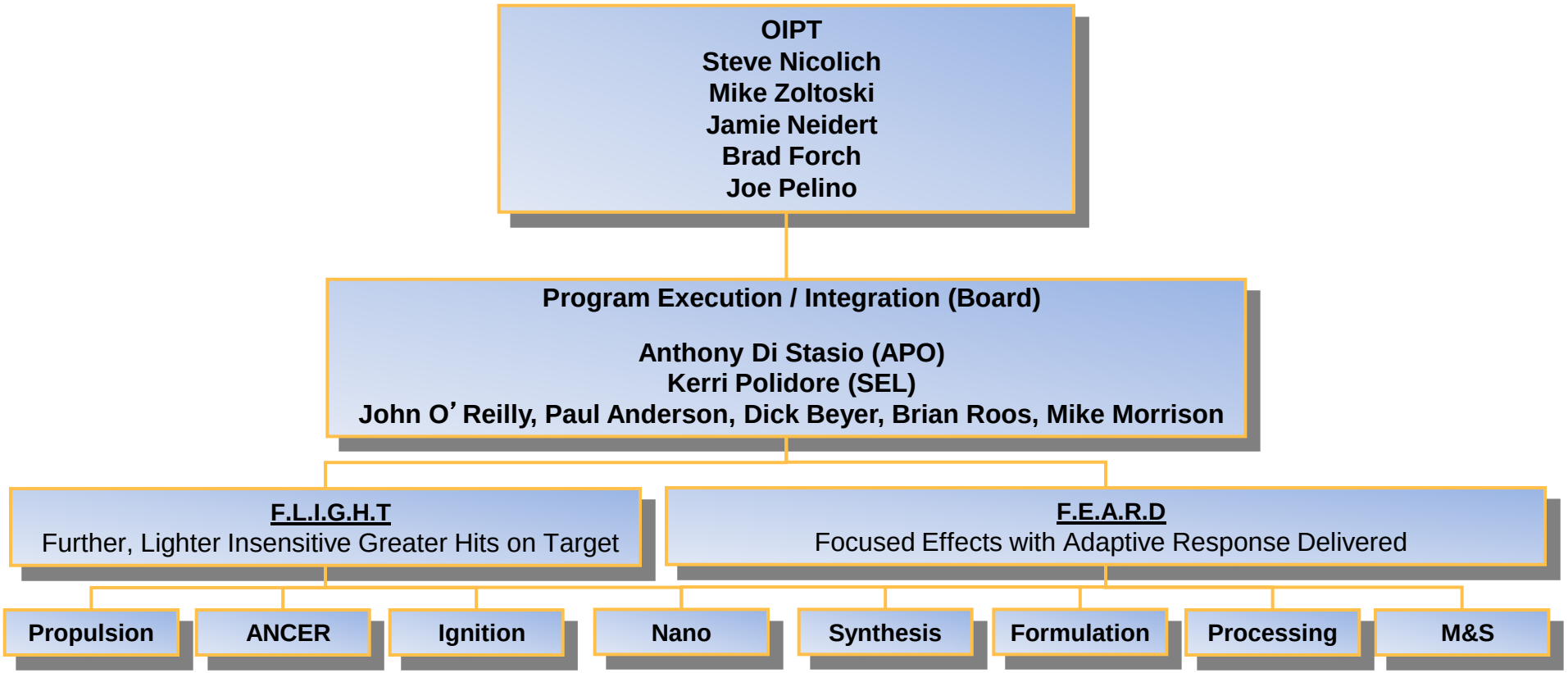
F.R.E.E.D.M. Organization



Why do energetics research?

Fuel tanks became incendiary bombs, ejector seats blasted from burning planes, a superheated machine gun opened fire spontaneously, missiles detonated. "It was pure hell," said Chief Warrant Officer Bob Henderson, "just ungodly."

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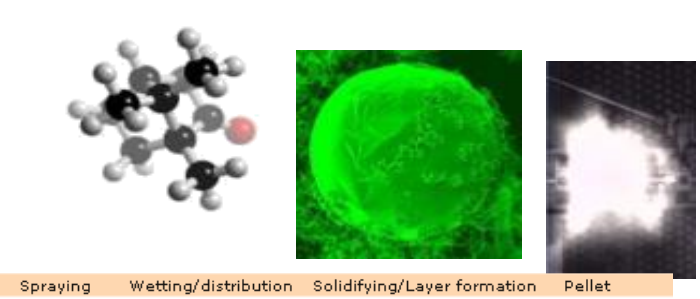
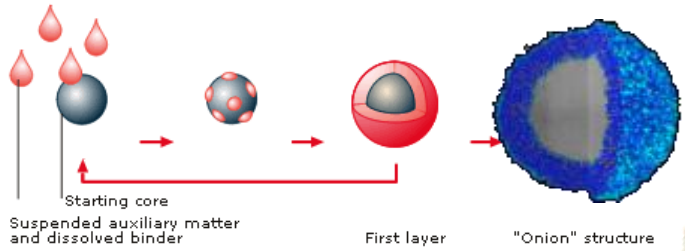
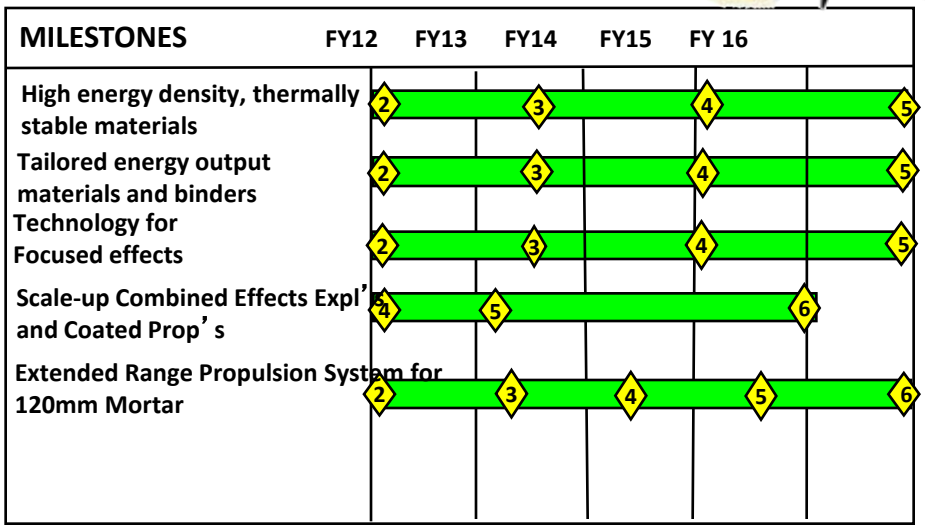




Schedule & Cost



Purpose

Provide insensitive, green energetic materials, enabling the capability to increase the lethality, range, precision, and utility of munitions while providing focused and variable effects through tailored energy release.

Products

- Higher energy density multi-purpose IM explosives for anti-armor and blast-frag warhead applications
- Extended range propulsion system prototypes
- Novel processing and precision coating techniques for highly efficient progressive charges
- Energetic technologies for focused & tailored energy release on target
- Novel materials to enable and compliment next generation IM initiation and ignition systems

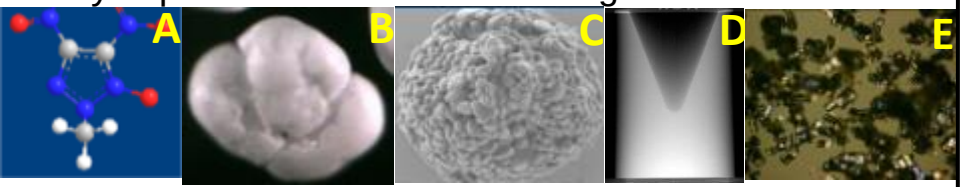
Payoff:

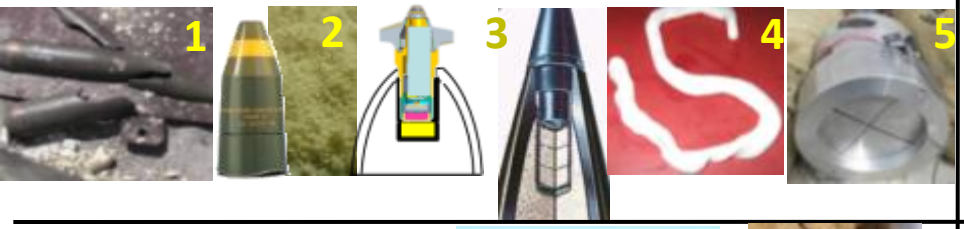
Faster (high density) FOB setup and extended range (better propellant) protection against multiple targets (tailored and focused effects) with more rounds (IM) readily available to the call for fire (IBD/HD)

Explosives Overview

Objective/Purpose

Increase soldier survivability, reduce logistical burden by implementation of novel energetic materials





Problems, Challenges & Risk

- Army Ordnance is subject to unplanned stimuli while in use, transport and storage.
- New materials can lead to safer greener compounds

Technologies

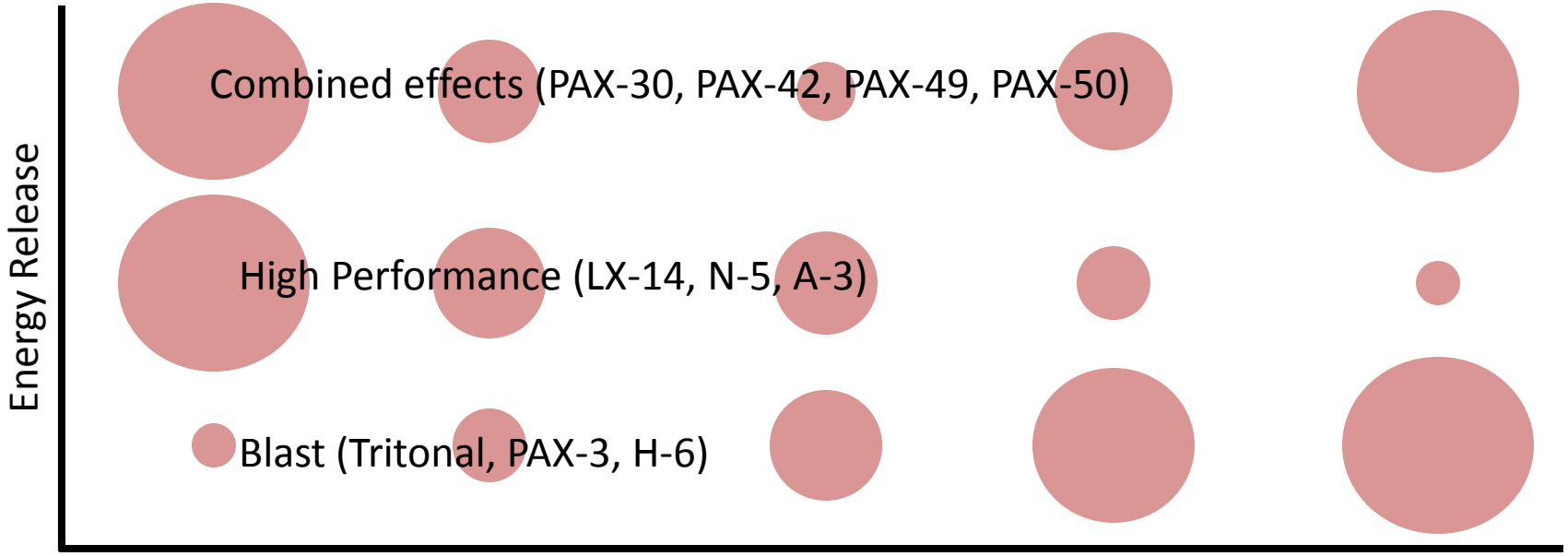
A. Ingredients
B. Protection
C. Processing
D. Loading
E. Analysis

Improvements

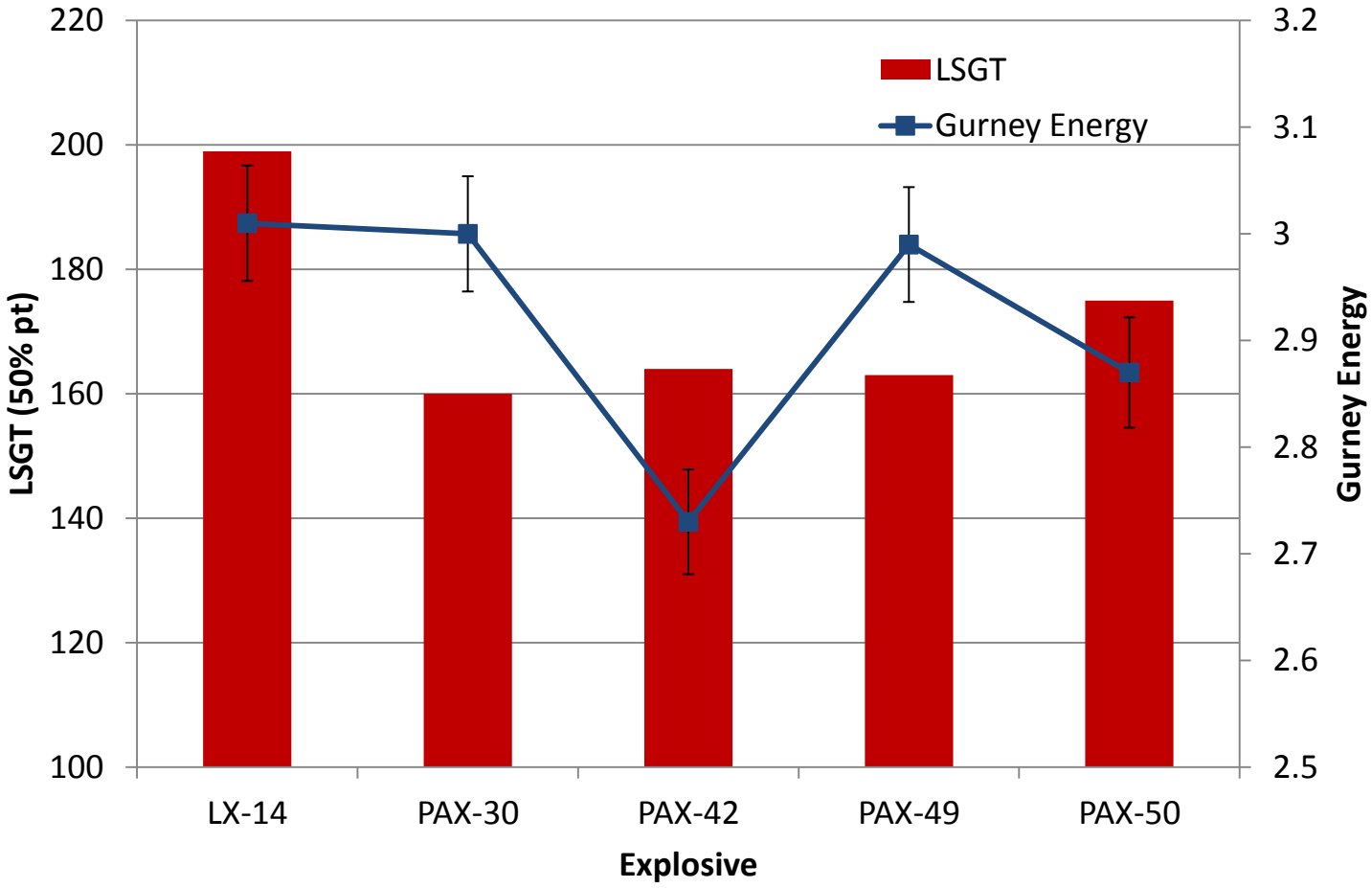
1. Transitioned TNT and Comp B replacements to PM-CAS/CCS
    1. Comp B replacement to be fielded
2. Transitioned safe, booster explosive to PM-CCS - To be fielded
3. Developed detonation train for precision guidance kit, M483 trainer, M483 WP round
4. PM-CCS leveraging flexible explosive technologies
5. Reduced risk of future explosive efforts with SABRE development

Combined Effects

Proper formulation of finely divided metals and semi-metals results in early metal oxidation, high Gurney energy, and higher enthalpy species (CO, H_2, etc) for later blast augmentation

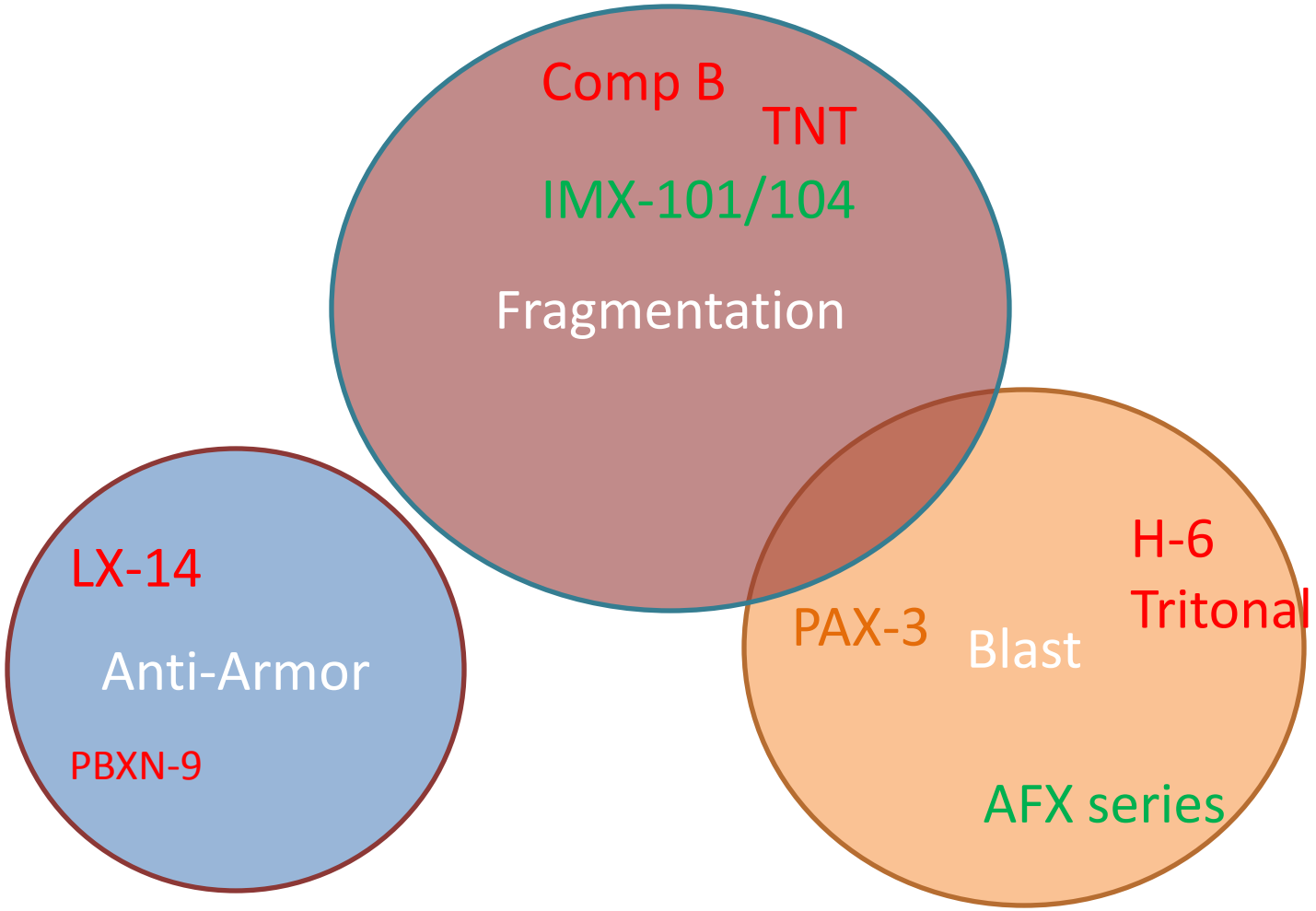


Combined Effects



Due to some nitramine being replaced with metals, shock sensitivity is lowered and IM properties are enhanced.

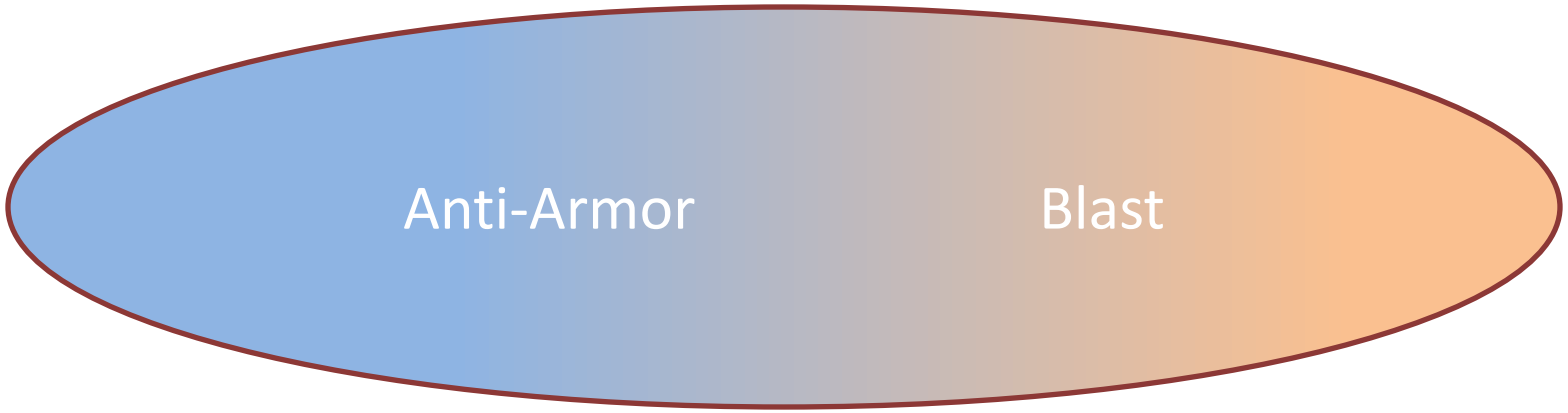
Current Technology



Time of energy release

Combined Effects

PAX-30, PAX-42, PAX-49, PAX-50



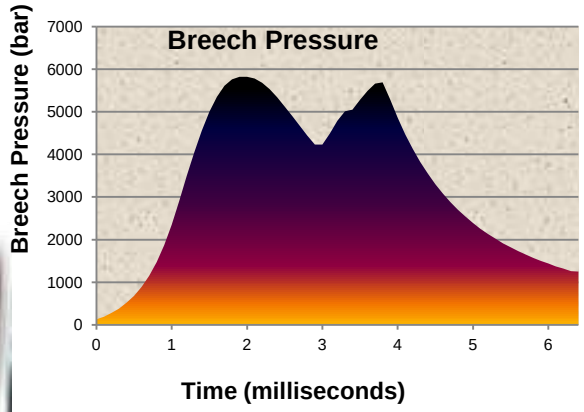
Time of energy release

Early energy release from energetic binders and metal particle type and size

Later blast obtained from early metal reaction leading to formation of high enthalpy species (CO, H_2, etc.)

A dual purpose explosive fill

Propulsion



Purpose:

- Extended Range existing and future delivery platforms
- Soft Launch- Reduce G-forces on precision and scalable munitions
- Incorporate Ramjet motor technology to 155mm Artillery projectiles
- Novel Ignition Mechanisms for Advanced Propellants
- Muzzle Pressure Management

Result(s):

- A TRL 5 extended range propulsion system prototype
- Improved formulation and design capabilities
- New ignition technologies for improved performance

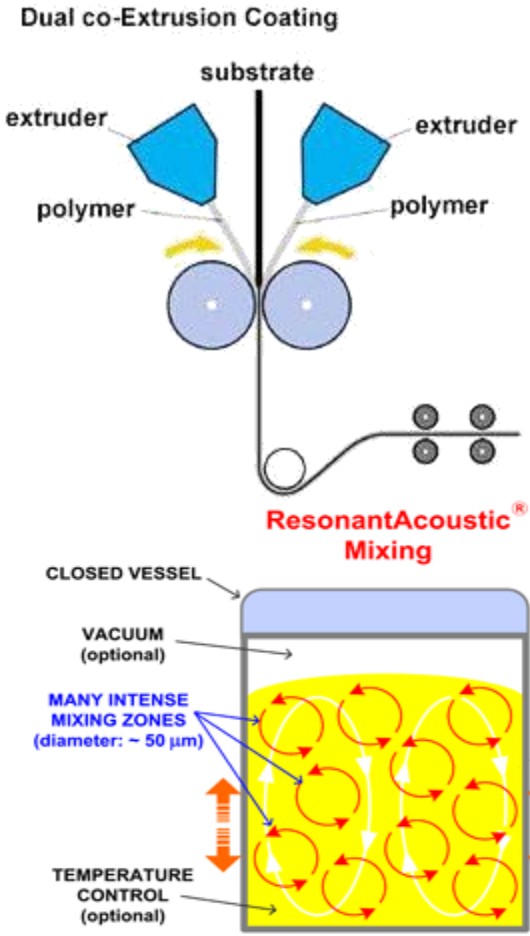
Payoff:

- Extended Range
- Increased Survivability of Precision and Scalable Munitions
- Increased Lethality

Novel Processing

Technical Idea: Novel processing for progressive charges

The current methods for manufacturing gun propellants is established and unchanged for many years. New methods of processing and adjusting the materials are needed. Increase in large gun caliber range will come from novel and exotic processing, which enables various shapes and forms of propellants with diverse ingredients.



Technical Goals: (what are the technical goals in each area)

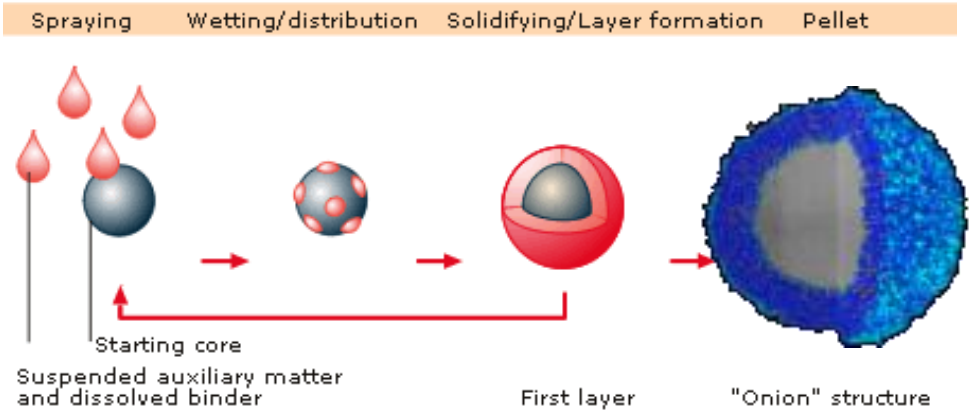
1. Successfully processing materials with very distinct properties into one propellant grain configuration.
2. Processing of larger batches of grains and test/confirmation of performance enhancements predicted by simulation and modeling

Why these are Technical Goals:

Our World War 2 processing technology for gun propellants is insufficient for the future Warfighters needs. New, more agile, robust methods for producing high volumes of propellant are imperative

Properly designing the grains to be both high performance and scalable is very difficult to achieve within a reasonable cost

120mm Extended Range



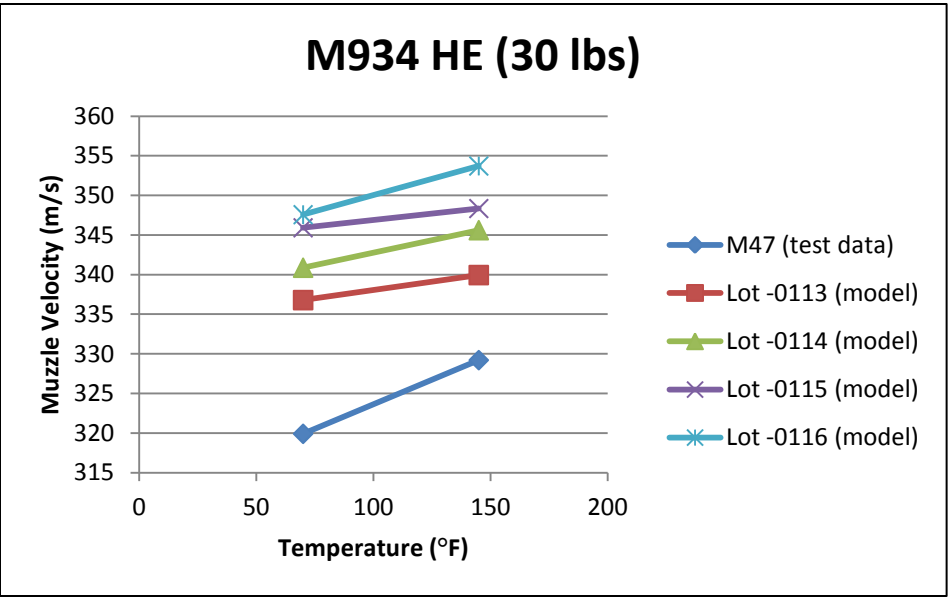
- ***Purpose:***
- Current capability gap in extended range mortar munitions.
- CPD requirement for 120 mm mortar systems.
- A FERA (Family of Extended Range Ammunition) for the 120 mm mortar will require conventional (propellant, projectile and gun) and non-conventional (addition of rocket motor) changes to current 120 mm mortar family.

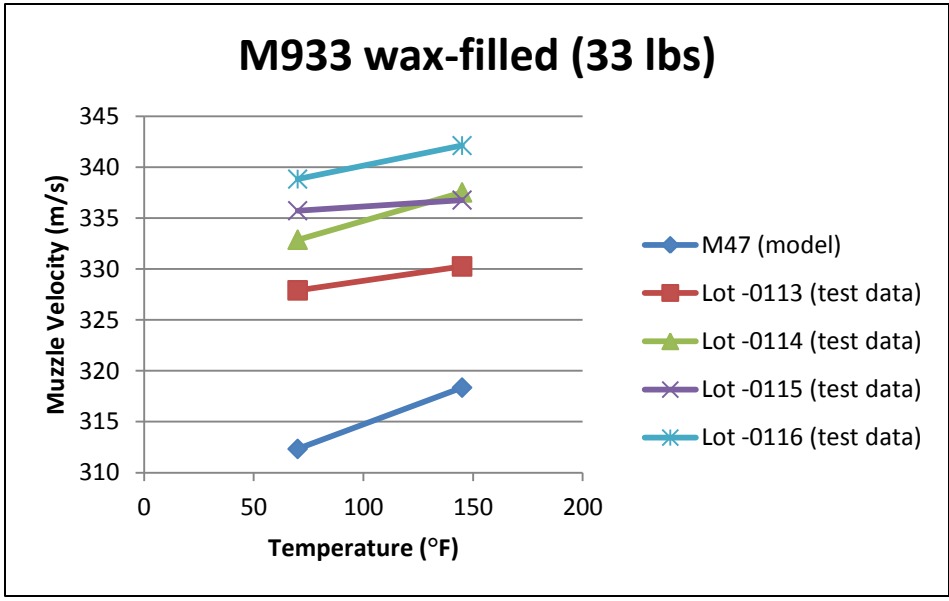
- ***Payoff:***
- Double the effective range of current Mortar system.
- Faster engagement of targets due to logistics of mortar system vs. artillery.
- Potential application to 60mm and 81mm mortars

APMI Extended Range

- Goal: Get 33# APMI projectile to 340 m/s muzzle velocity in standard 120mm M298 tube.
- Approach: High energy, modified triple base flake propellant, deterred for progressivity
- Results: 1st iteration – 336 m/s at ambient, Pmax @ hot = 17900 psi, improved temperature coefficient compared to baseline
- Next step: Modify formulation to improve performance and reduce BOP, instrumented testing to verify pressure vs. travel requirements – May 2012

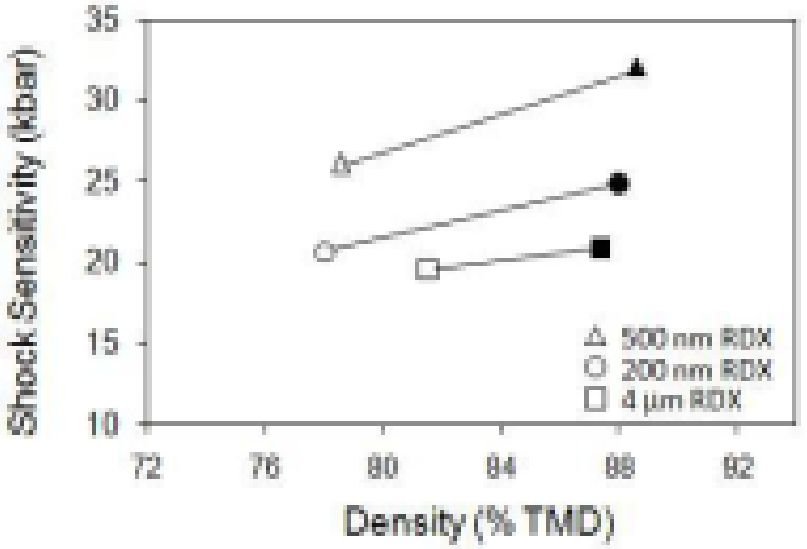
Comparison to Baseline

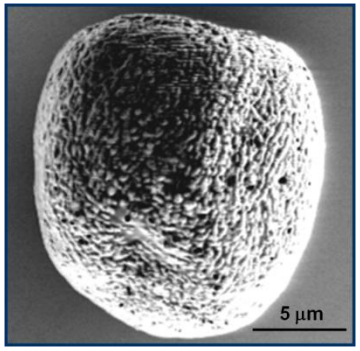


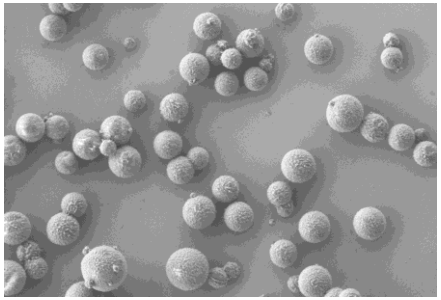


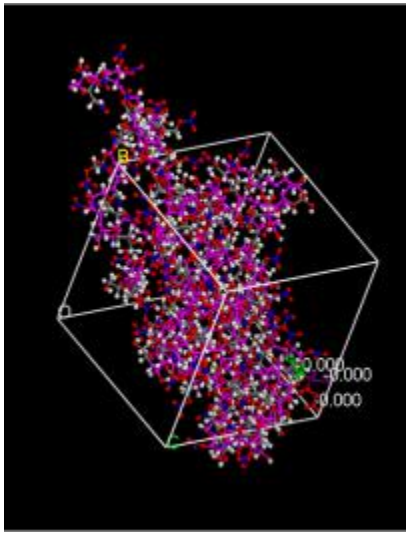
•Superior performance with less sensitivity to temperature changes compared to baseline propellant, M47.

Nanomaterials









Description:

- Nanomaterials posses high surface area which translates to higher rates of surface reactions which may lead to enhanced lethality.
- Newer metals and semimetals possess minimal oxide layer which traditionally hampered efficient reaction of aluminums.
- Nanoenergetics provide substantially less shock sensitivity than bulk powder. Potential applications include less sensitive smaller boosters, and LEEFI-sensitive boosters for MEMS “fuze-on-a-chip” integration.
- Nanothermites for delayed energy release/enhanced blast

Payoff:

- Increased know-how of nanomaterials safety, integration, and utilization into existing items and formulation.
- Provide Warfighter with increased lethality & survivability
- Production base expansion of Plasma Reactor for synthesis of novel nanomaterials and new alloys.

Questions