NAVSEA
NAVAL SEA SYSTEMS COMMAND

Electromagnetic Railgun

NDIA Joint Armaments

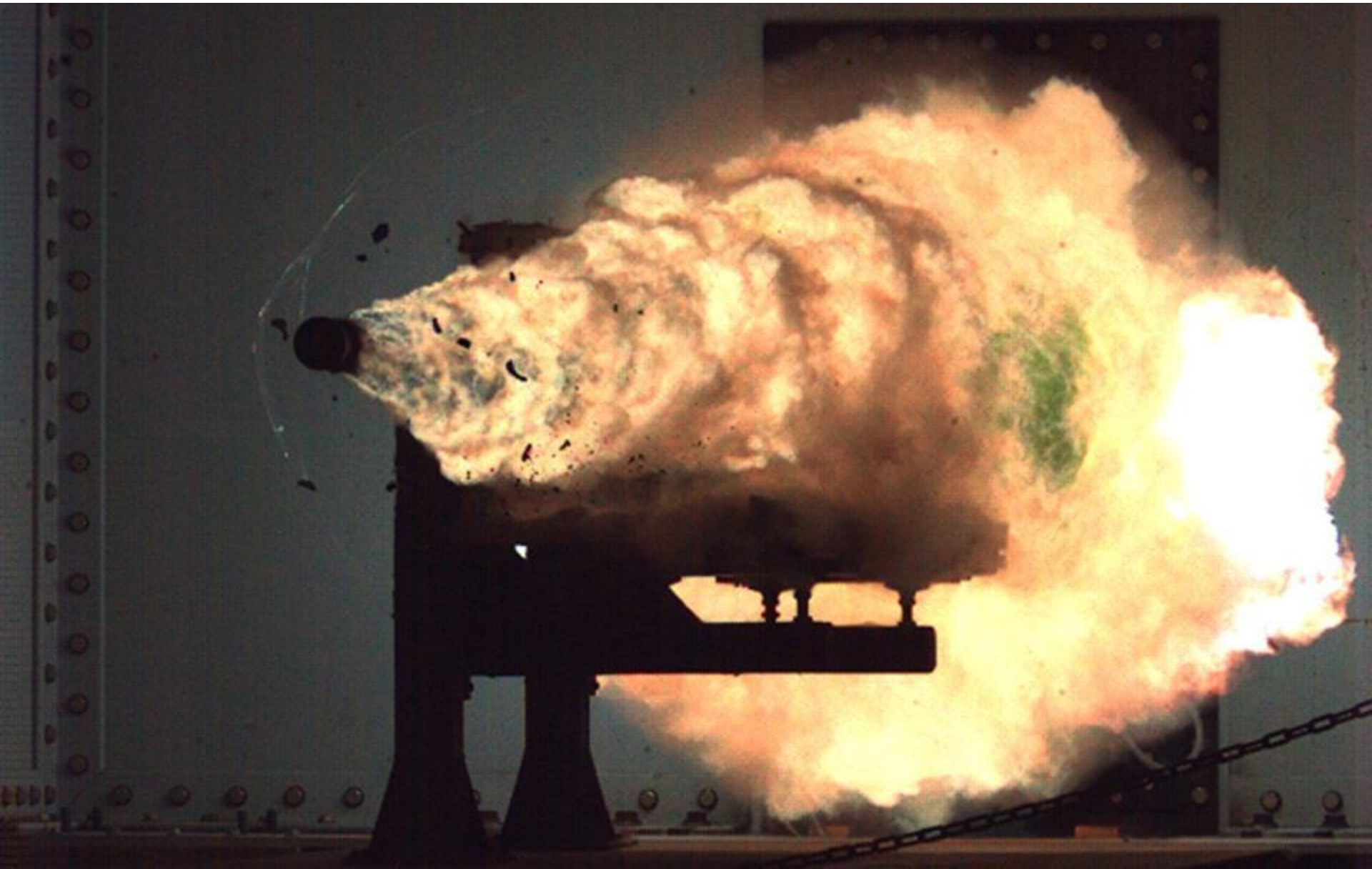
Forum, Exhibition & Technology Demonstration

14 May 2014

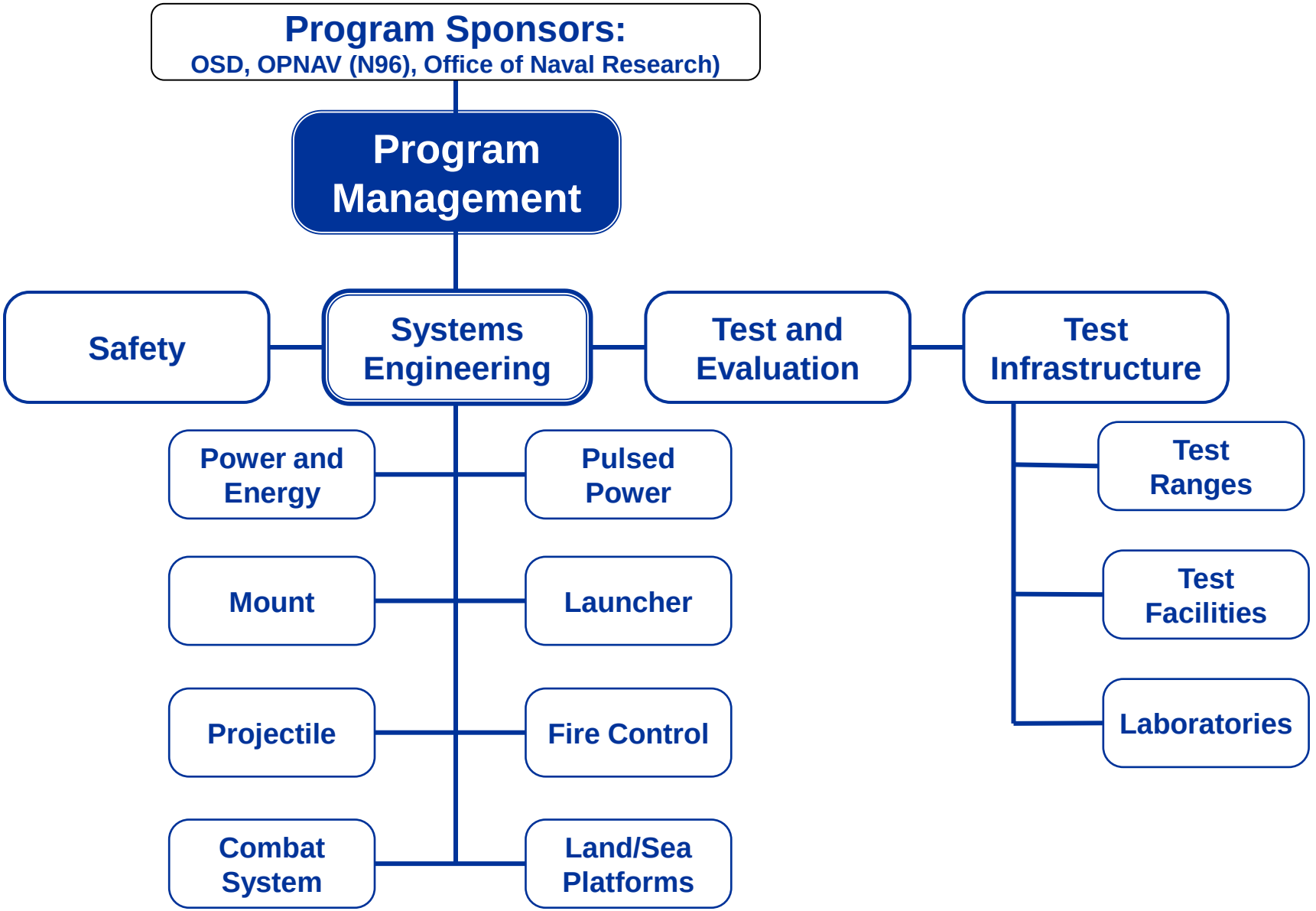
LCDR Jason Fox, USN

Assistant PM, Railgun Ship Integration

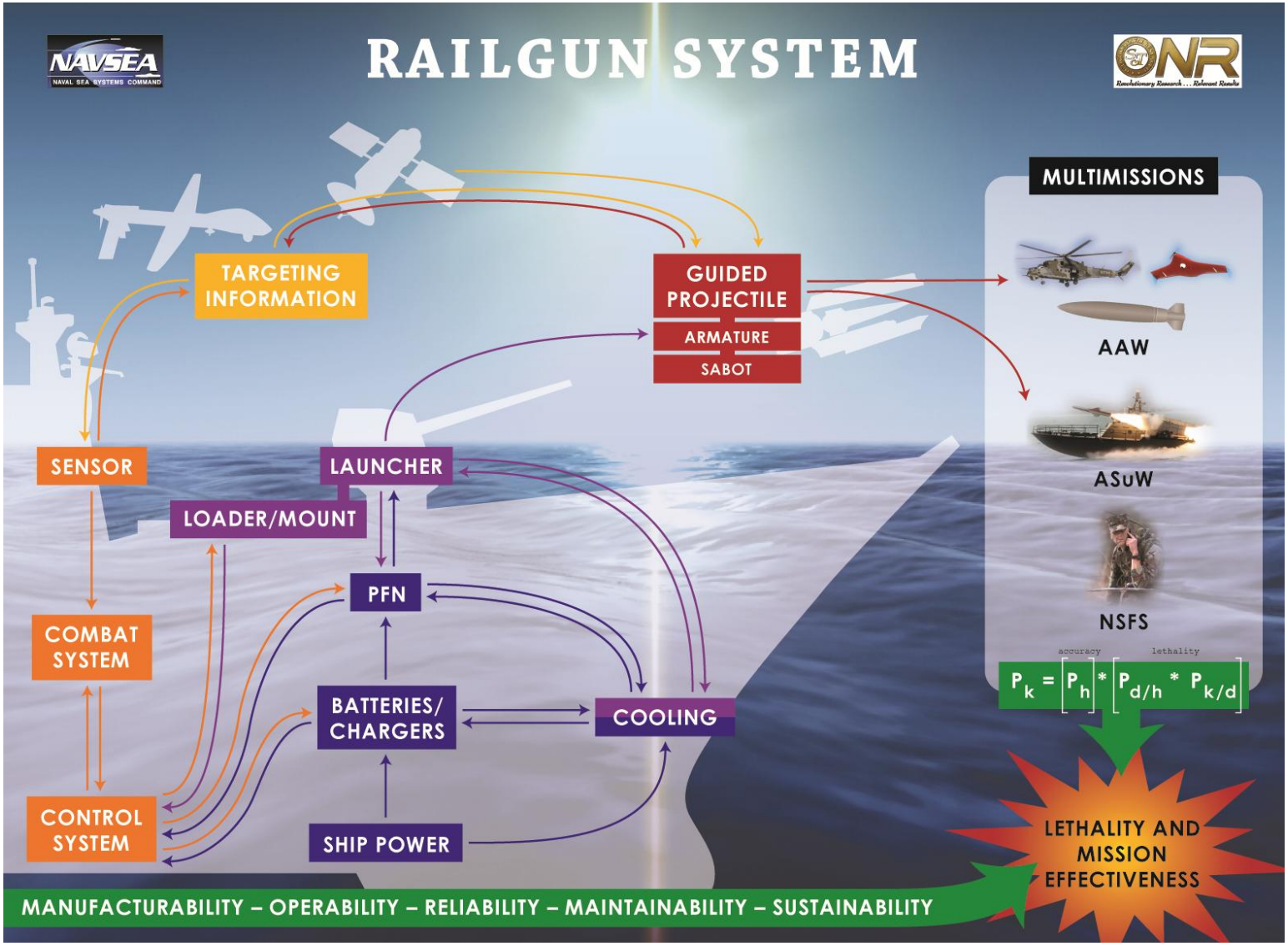
EM Railgun & Hyper Velocity Projectile



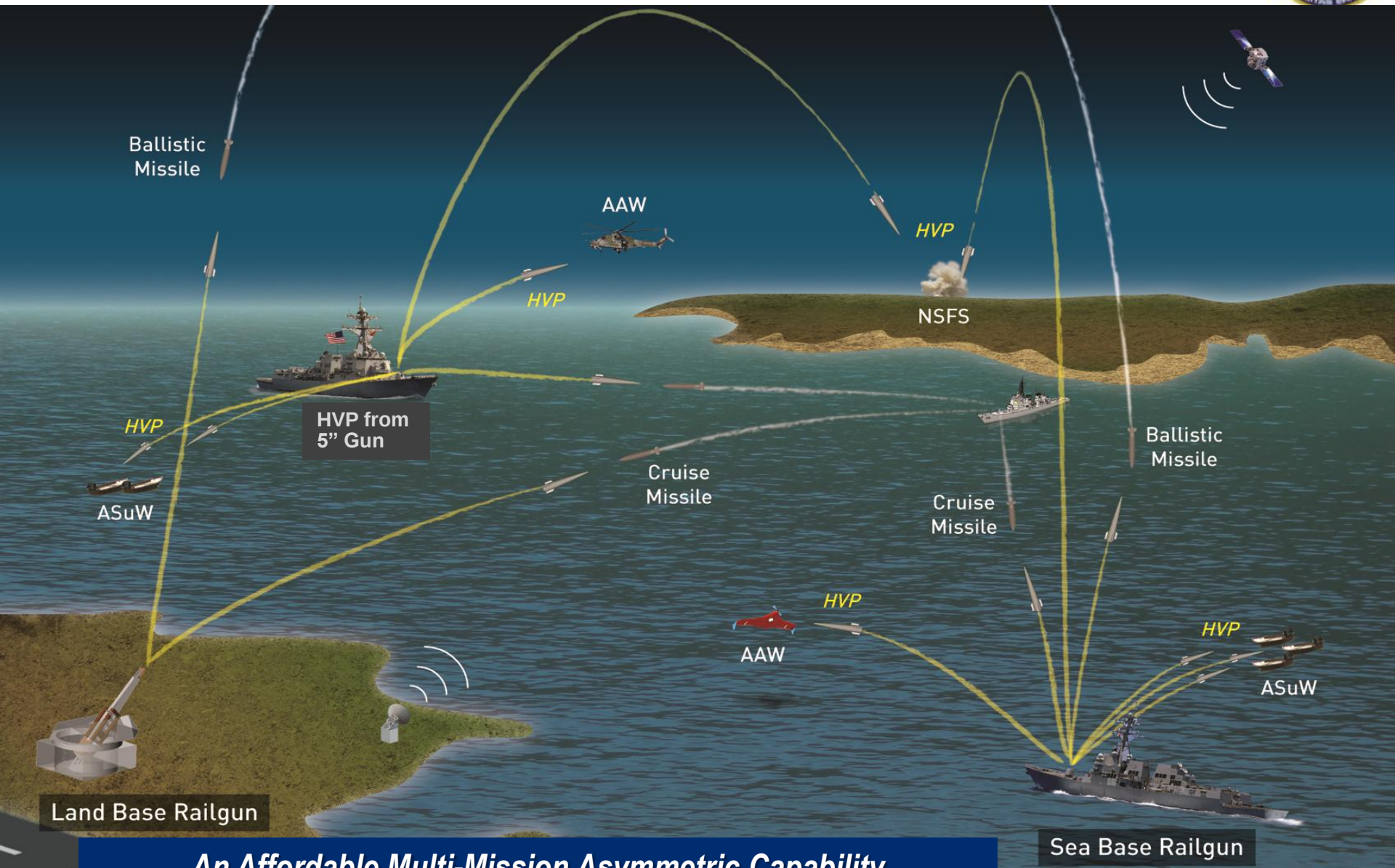
Program Structure



Railgun System Integration



Railgun and Hyper Velocity Projectile



An Affordable Multi-Mission Asymmetric Capability

Multi-Mission Railgun

32 Mega Joule Laboratory Launcher

Railgun Development Focus

- Technology Proven at 32MJ Muzzle Energy
  - Focus shifting to rep rate operations
  - Tactical Barrel & Mount Compatibility
- Rep Rate 32MJ Launcher & Test Stand
  - Establish Manufacturing with BAE Systems
  - Validate Bore Life during Rep Rate Ops
- Rep Rate 32MJ Gun Mount (100NM capable)
  - Leverage Navy Gun Mount Experience
  - Integrate HVP Handling & Initialization
  - Design for Pulsed Power Transfer & Cabling

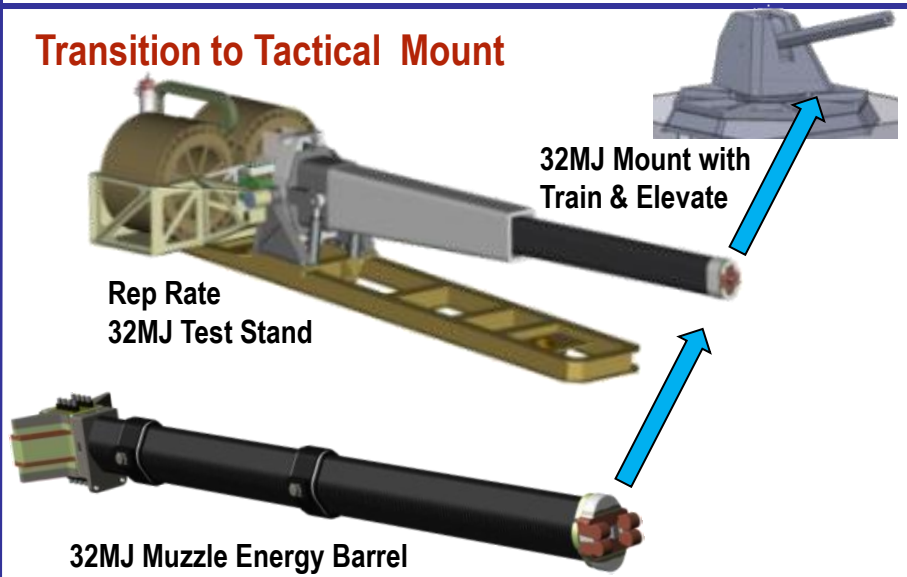
Warfighting Payoff

- Responsive, Wide Area Coverage
- Precision fires via guided munitions
- Deep magazines – cost effective
- Enhanced safety with Low Collateral Damage
- Multi-mission, Multi-Barrel Hyper Velocity Projectile (HVP)

HVP & Gun Systems equates to Distance

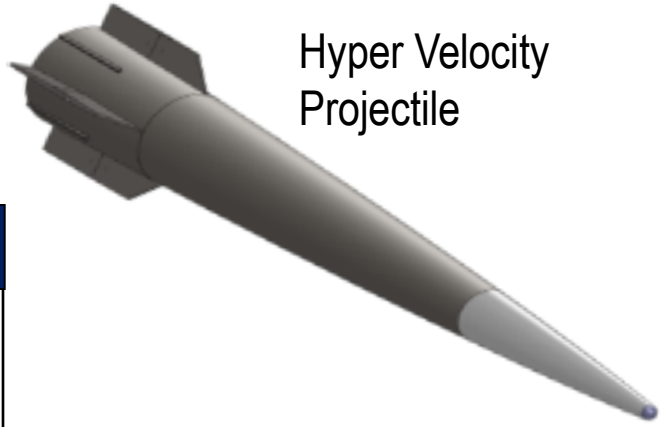
- 20 MJ Railgun → 50 nautical miles
- 32 MJ Railgun → 110 nautical miles

Transition to Tactical Mount



Multi-Mission HVP

Missions



Technologies

Weapon Systems

- *High speed launch enables effectiveness*
- *High density electronics enables packaging & survivability*
- *High computational power enables advanced tracking & guidance algorithms*

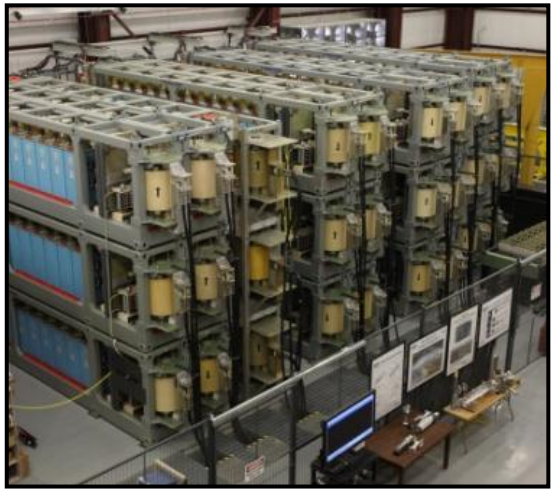
Real Progress

Significant Barrel Life

Modular Approach – multiple ship types

Power & energy for multi-mission

Projectile component risk reduction



Naval Railgun – Focus of Effort

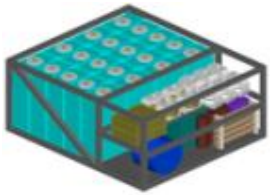
Launcher

- Multi-shot barrel life
- Barrel construction to contain rail repulsive forces
- Scaling from 8MJ (state of the art) to 32MJ
- Thermal management techniques
- M&S – Represent interaction between bore and projectile

Projectile

- Dispensing and Unitary Rounds
- Gun launch survivability
  - 20 to 45 kG acceleration
  - Aero Thermal Risk Management
- Hypersonic guided flight for accuracy
- Lethality mechanics

Power & Energy

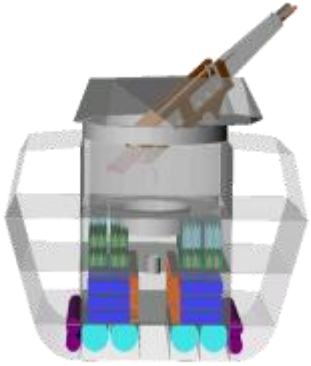


Pulsed Power Capacitors

Batteries

- Energy Density
- Rep rate operation & thermal management
- Switching

Ship Integration



- Dynamic Power Sharing
- Space and Weight
- Cooling
- EM Field Management

Joint High Speed Vessel

Near Term Demonstration
- 50NM Manually Loaded Railgun Launcher
- NSFS Demonstration

Long Term Demonstration (Configuration Pictured)
- 50-110NM Multi-Shot Capable Railgun Mount
- Ready for At-Sea Demonstration

Ideal Platform for Near and Long Term Demonstrations

Path Forward

- Naval EM Railgun is a Game Changer
- Opportunities
  - Barrel Life Development
  - Critical Projectile Components
  - Compact Power & Energy Power Conversion
  - High Energy Density Pulsed Power
  - Understanding Ship and Weapons System Integration Requirements
  - Execution of Demos to validate Simulation/Designs

Transition to Land & Sea Demonstrations

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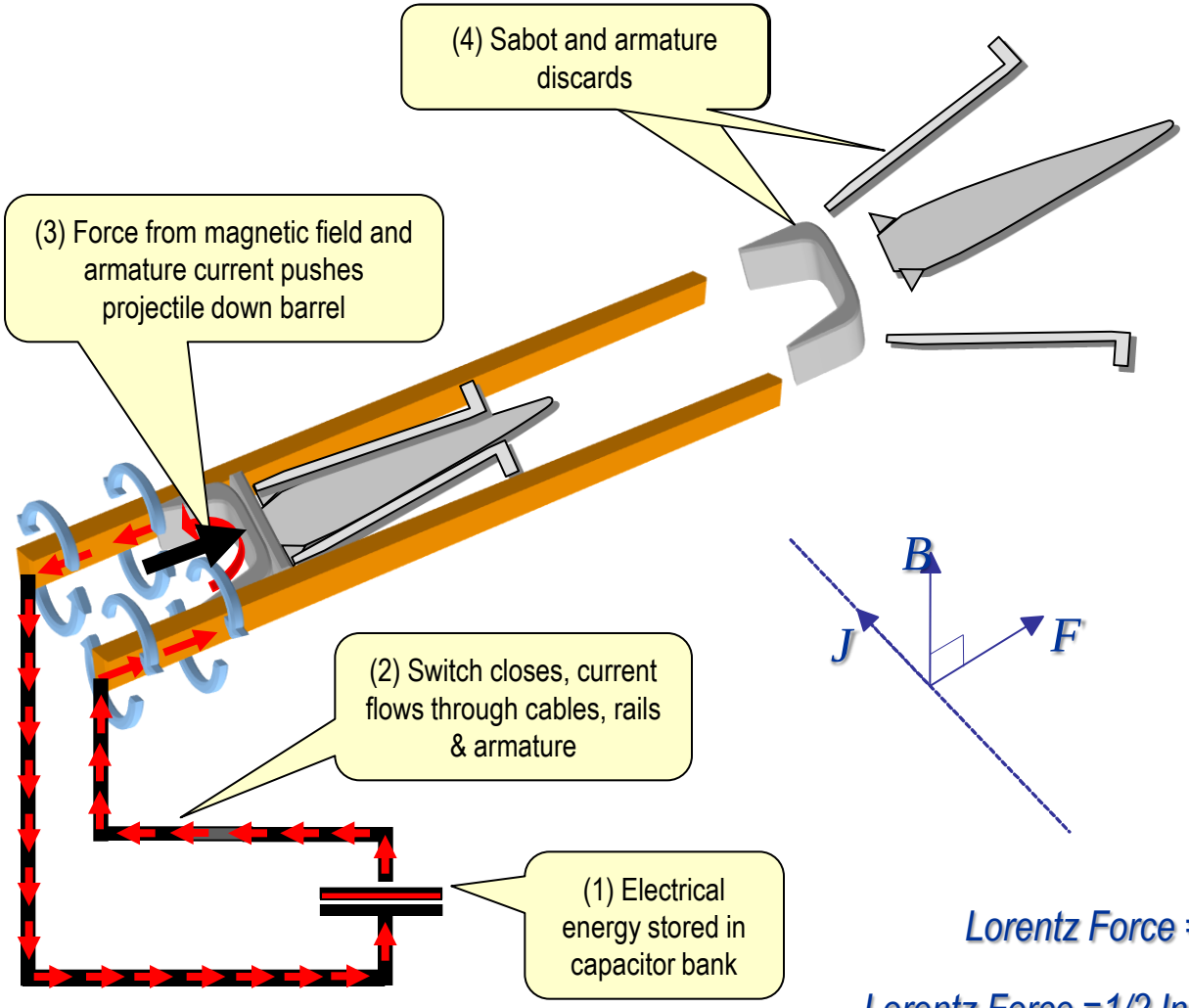
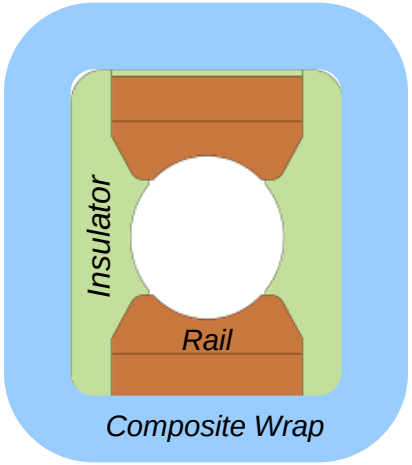
Backup

How Railgun Works

Operating Principle



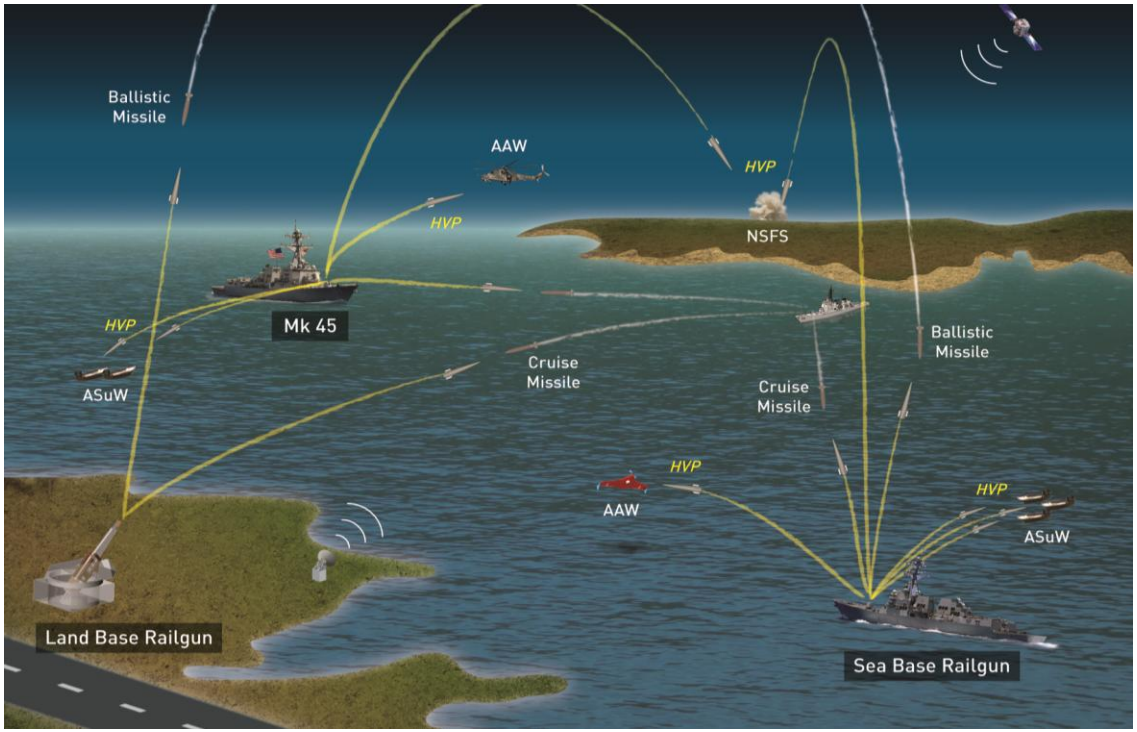
Cross-Section



Lorentz Force = Current (J) X Magnetic Field (B)
or
*Lorentz Force =1/2 Inductance Gradient (L') * Current (I)^2*

Railgun Operational Impact

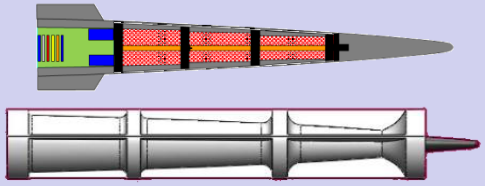
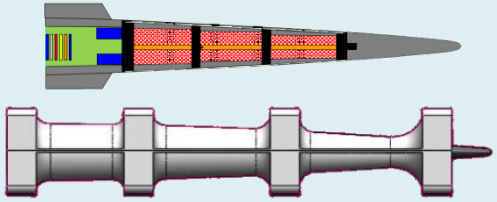
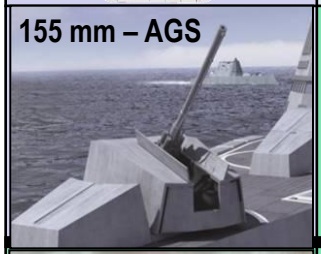
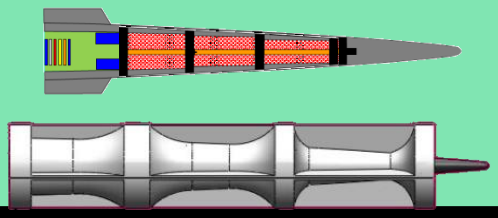
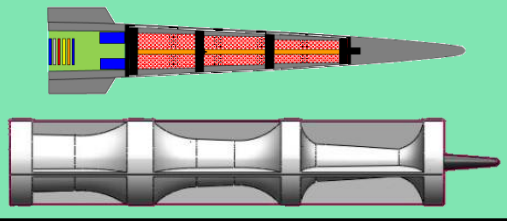
- *Wide Area Coverage*
  - Increased speed to target
  - 100+ NM
- *Accelerates operational tempo*
  - Faster attrition of enemy personnel and equipment
  - Operation timeline shifts left
- *Reduces Cost per Kill*
  - Lower Unit Cost
  - Lower handling Cost
- *Enhances Safety*
  - Reduced collateral damage
  - Simplified storage, transportation and replenishment
  - No unexploded ordnance on battlefield
- *Reduces Logistics*
  - Eliminates gun powder trail
  - Deep magazines



- *Multi-Mission Capability*
  - Naval Surface Fire Support
  - Surface Warfare
  - Missile Defense
  - Long Range Fires

Multi-Mission Capable for Offense and Defense

Commonality Approach

GUN SYSTEM	PROJECTILE (SABOTED & SUB-CALIBER)	MISSION & WARHEAD TYPE	TRANSITION OPPORTUNITES	GAME CHANGING CAPABILITY
5" MK 45 MOD 2/4 		NSFS – HE	113 Barrels (PEO IWS)	GUIDED 26 – 41 NM NSFS/ASCM/ASuW
20 – 32 MJ Railgun 		NSFS – HE NSFS - KE	FUTURE (PMS405/PEO IWS)	GUIDED 50 - 100 NM NSFS/ASCM/ASuW/ Future Threats
155 mm – AGS 		NSFS – HE	6 Barrels (PEO IWS)	GUIDED 40 NM NSFS/ASCM/ASuW
155 mm 		Ground Fires – HE	800 ARMY 300 MARINE ASSETS	GUIDED 17 NM Fires/CMD

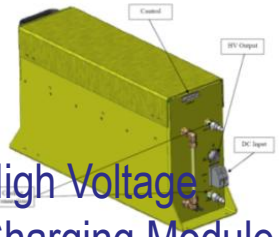
Multi- Barrel , Multi- Mission, & Multi-Service Applications

Power & Energy

Pulsed Power at the Electromagnetic Launch Facility, Dahlgren, VA

Advanced Energy Systems

High Density Power Electronics



High Voltage Charging Module

- Charging Power Supplies for Advanced Energy Systems
- Converting Ship's Power to High Voltage for Electric Weapons
- Supports Electric Drive, Railguns, Lasers & Radars

Pulsed Forming Network

Actively Cooled Rep-Rate Pulsed Power Module

for Mobility & Demo Platform Flexibility

- Capacitor based PFN
- Higher Energy Density lowers shipboard volume/footprint
- Rep rate operation & thermal management

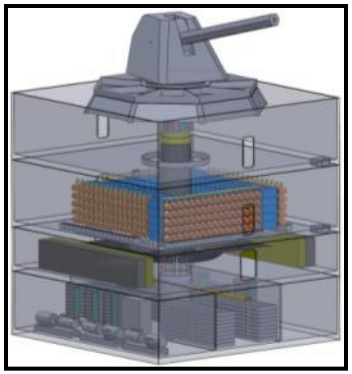
Battery Energy Storage

Lithium Ion Battery Packet

Battery Energy Storage in ISO Container for Mobility & Demo Platform Flexibility

- Energy Storage to buffer Prime Generators
- Ready Reserve Energy for response to "quick" threats
- Requires close Ship Safety Design, Test & Monitoring

System / Ship Integration



- Dynamic power sharing across platform
- Designing with Space and Weight Constraints
- Assessing Thermal and EM Field management