



Electromagnetic Railgun

**ASNE Combat System
Symposium
26-29 March 2012**

**CAPT Mike Ziv,
Program Manager, PMS405
Directed Energy & Electric Weapons
Program Office**

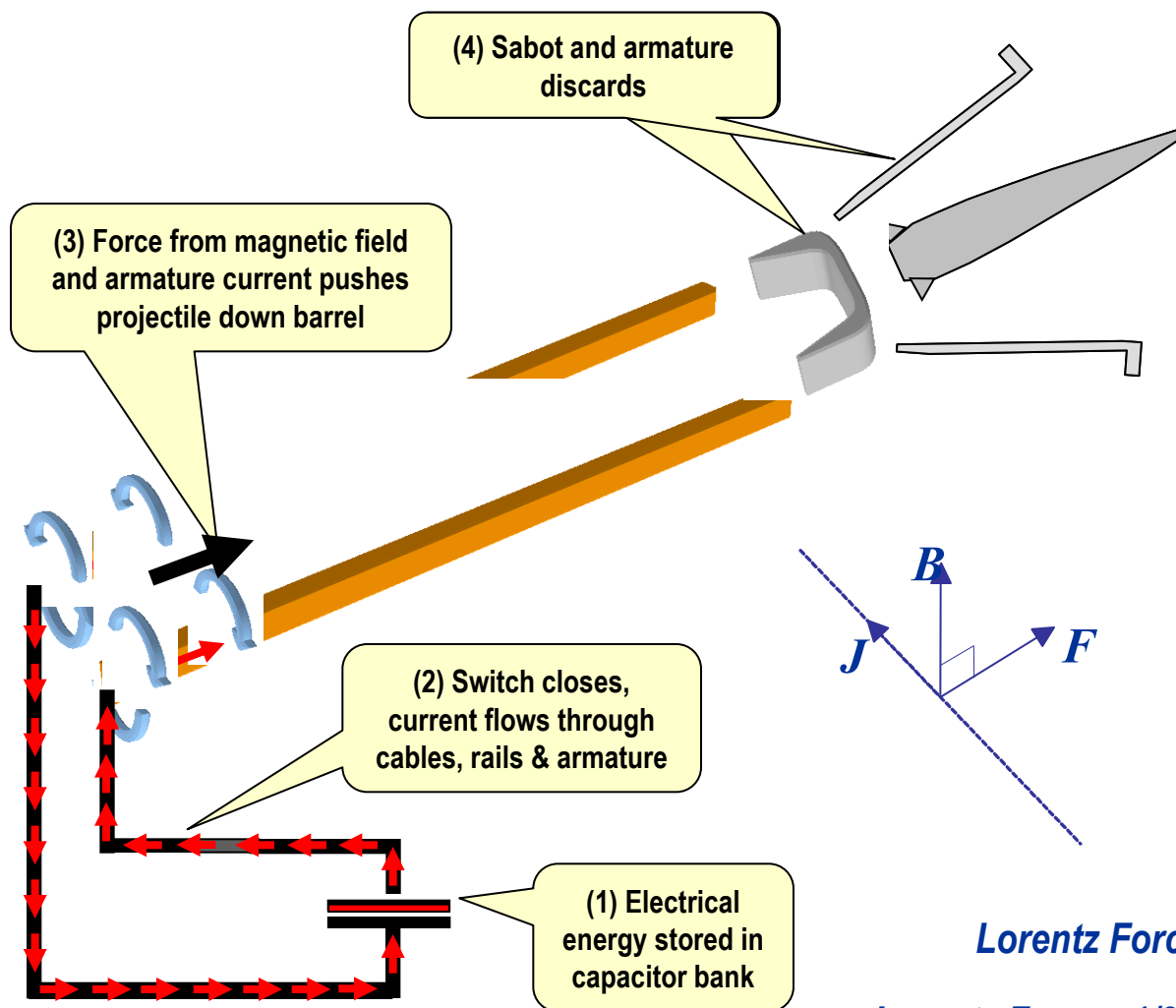


Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE MAR 2012		2. REPORT TYPE		3. DATES COVERED 00-00-2012 to 00-00-2012	
4. TITLE AND SUBTITLE Electromagnetic Railgun				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Directed Energy & Electric Weapons Program Office, Washington Navy Yard, DC, 20376				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES Presented at : Combat Systems Symposium 2012: March 26-27, 2012, Sheraton National Hotel, Arlington, VA					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 13	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

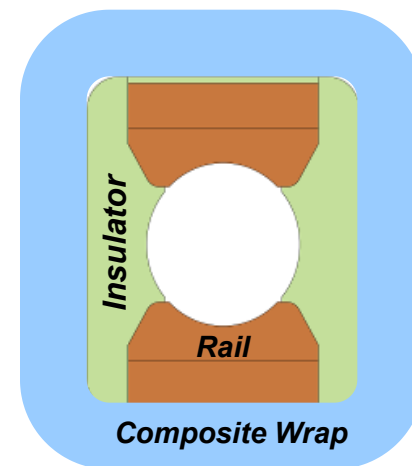
How Railgun Works



Operating Principle



Cross-Section



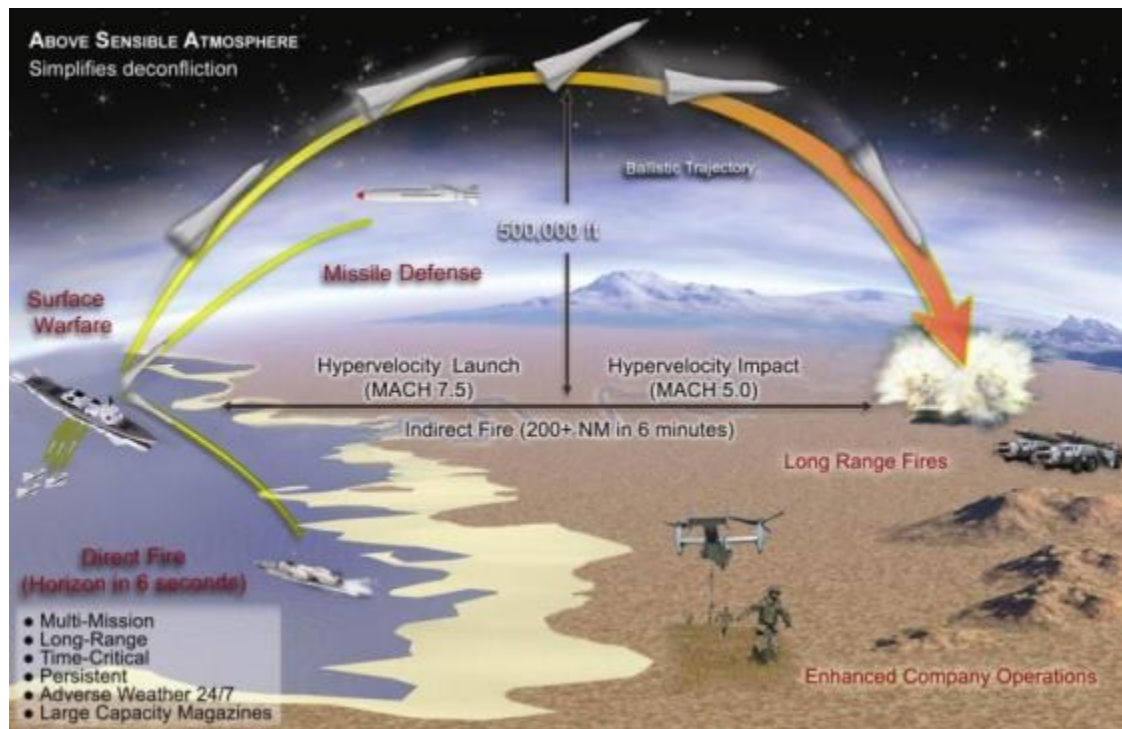
$$\text{Lorentz Force} = \text{Current } (J) \times \text{Magnetic Field } (B)$$

$$\text{or} \\ \text{Lorentz Force} = 1/2 \text{ Inductance Gradient } (L') * \text{Current } (I)^2$$

Railgun Operational Impact



- **Wide Area Coverage**
 - Increased speed to target
 - 200+ 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**
 - No risk of sympathetic detonation
 - Simplified storage, transportation and replenishment
 - Reduced collateral damage
 - No unexploded ordnance on battlefield
- **Reduces Logistics**
 - Eliminates gun powder trail
 - Deep magazines

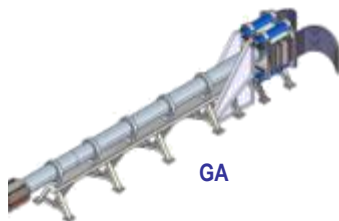
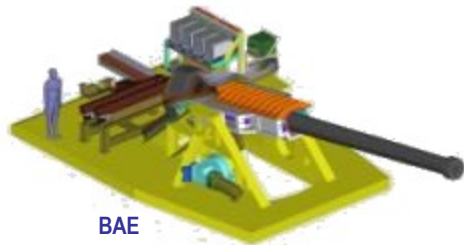


- **Multi-Mission Capability**
 - Surface Warfare
 - Missile Defense
 - Long Range Fires
 - Direct Fire
 - ASuW

Multi-Mission Capable for Offense and Defense

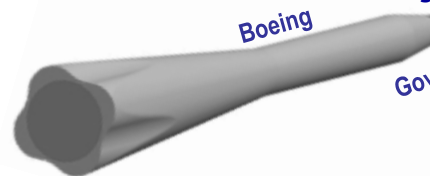
Naval Railgun – Key Elements

Launcher



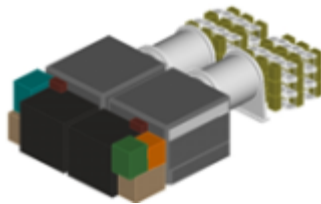
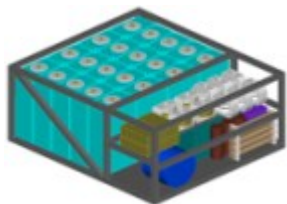
- Multi-shot barrel life
- Barrel construction to contain rail repulsive forces
- Scaling from 8MJ (state of the art) to 32MJ to 64MJ Muzzle Energy
- Thermal management techniques
- M&S – Represent interaction between bore and projectile

Projectile



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

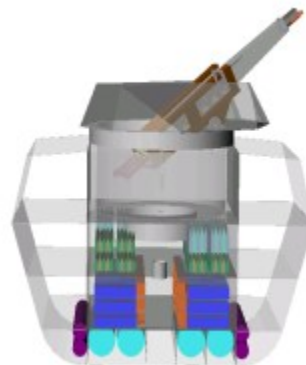
Pulse Forming Network (PFN)



Capacitors or Rotating Machines

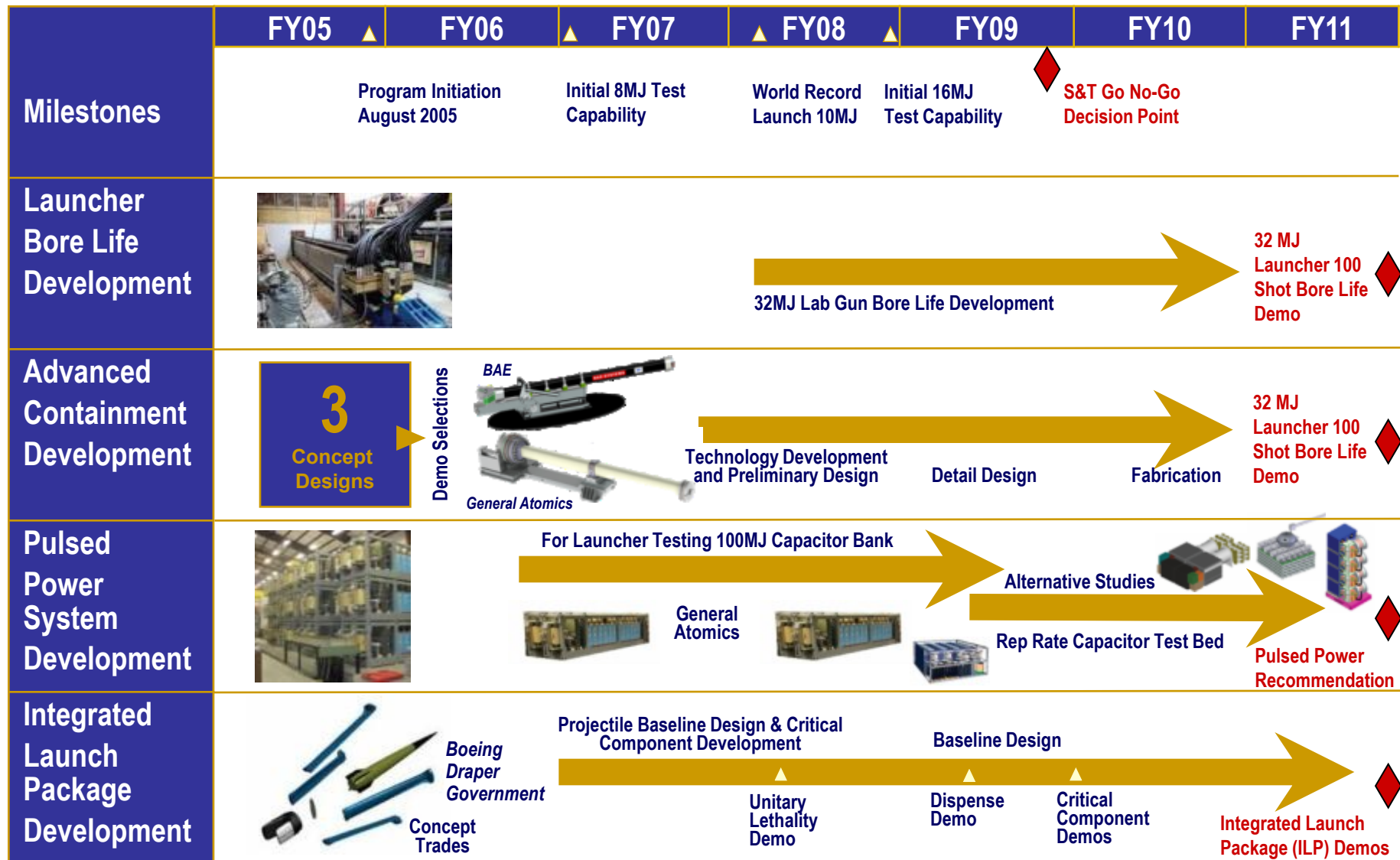
- Energy Density
- Rep rate operation & thermal management
- Switching
- Torque management and multi-machine synchronization (rotating machine)

Ship Integration



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

EM Railgun INP Phase I





Lab Launcher



GA Med-Cal Blitzer (IRAD)



Rep-Rate Test Bed



BAE 5M Prototype



Dispense Test

- Muzzle energy:
 - From 6MJ to 32MJ
- Bore Life
 - From 10s to 100s
 - Multiple configurations & materials
- Industry Launcher Prototypes
 - From concept to hardware
- Pulsed power
 - From single shot
 - To multi-shot capable design
- Projectile
 - From slugs & sand catch
 - To instrumented and dispensing flight bodies on open range
- Mission
 - From Land Attack
 - To Multi-Mission Initiative

Advanced Containment Launchers

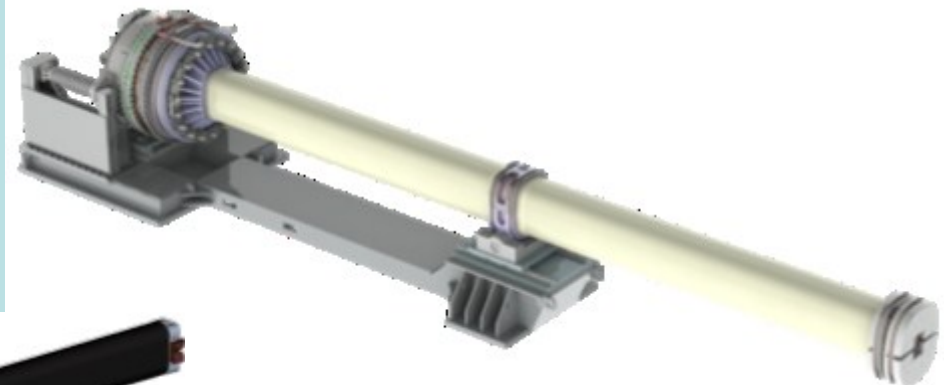


The industry developed Advanced Containment Launchers (ACLs) detailed designs are competition sensitive and each include unique materials, however they both share the following attributes:

- Advanced composite containment designs
- Advanced insulator materials



GA 10-meter ACL

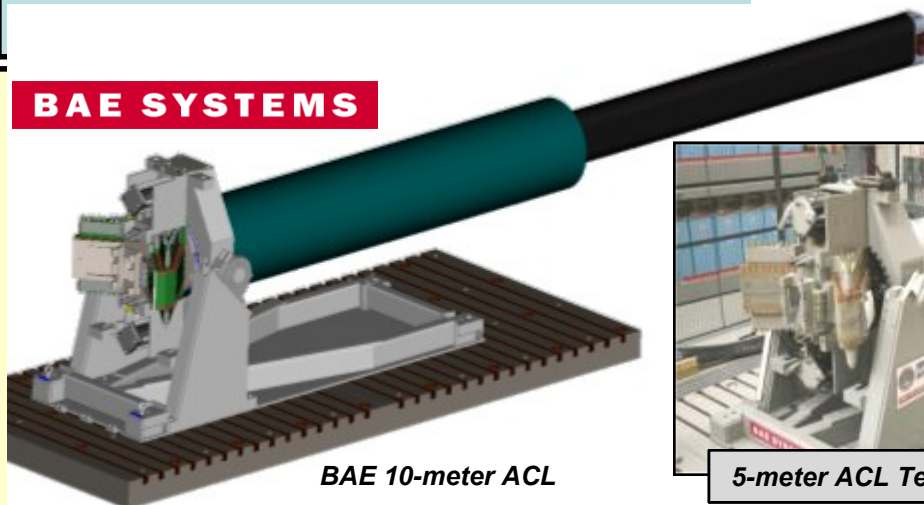


'Blitzer' Testing at DPG



- Subscale ACL launcher ('Blitzer') built by GA to provide risk reduction. Multiple test series have been completed at Dugway Proving Grounds (DPG), Utah
 - Full-scale 10-meter ACL in production
 - GA 10-meter ACL scheduled to be delivered to the Electromagnetic Launch Facility (EMLF) at NSWC Dahlgren and complete testing during the 1st quarter of FY2012

BAE SYSTEMS



BAE 10-meter ACL

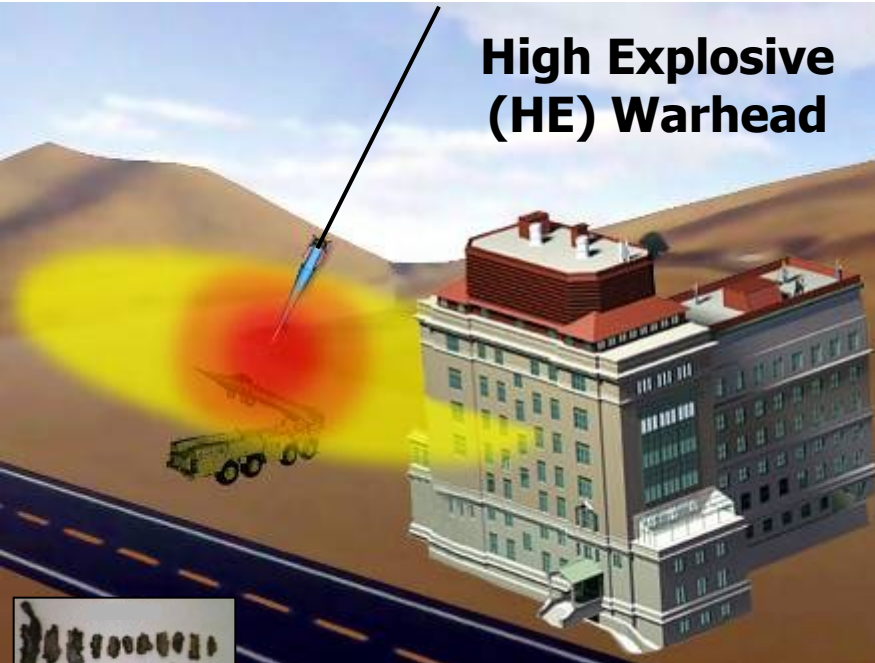


5-meter ACL Testing at EMLF

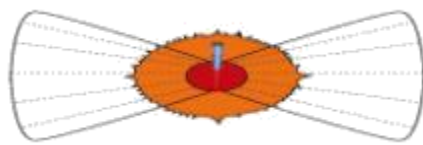
- 5-meter version of 10-meter ACL recently tested at EMLF (1/2011) with full-scale bore (cross-section), breech, muzzle and mount.
 - Full-length ACL in production.
- BAE 10-meter ACL scheduled to be delivered to the Electromagnetic Launch Facility (EMLF) at NSWC Dahlgren and complete testing during the 4th quarter of FY2011

HE versus KE Projectiles

High Explosive (HE) Warhead

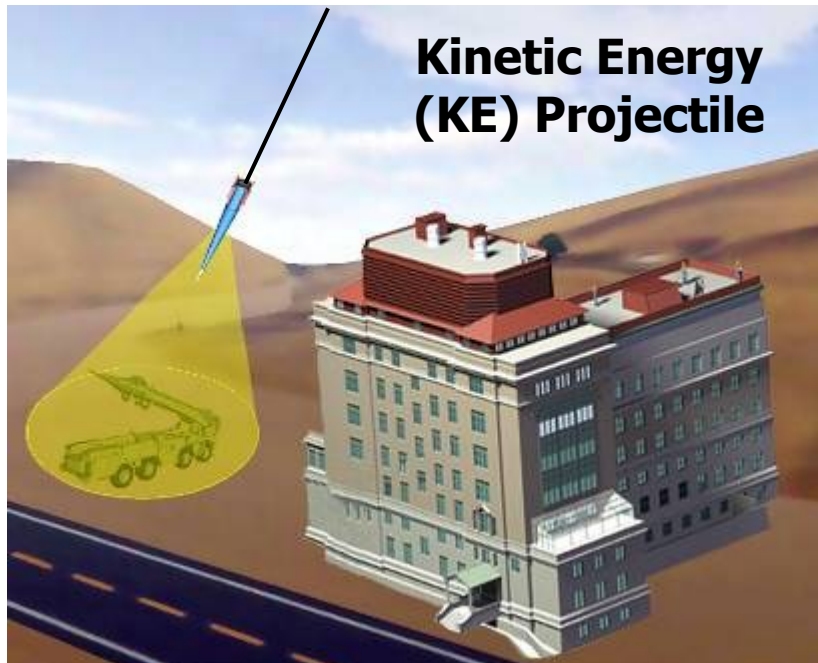



Non-uniform frags

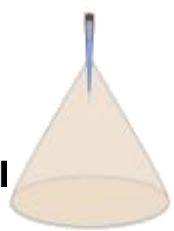


- **Blast Overpressure**
- **Large Area of Fragment Spray**
- **High Collateral Damage**

Kinetic Energy (KE) Projectile



Uniform frags



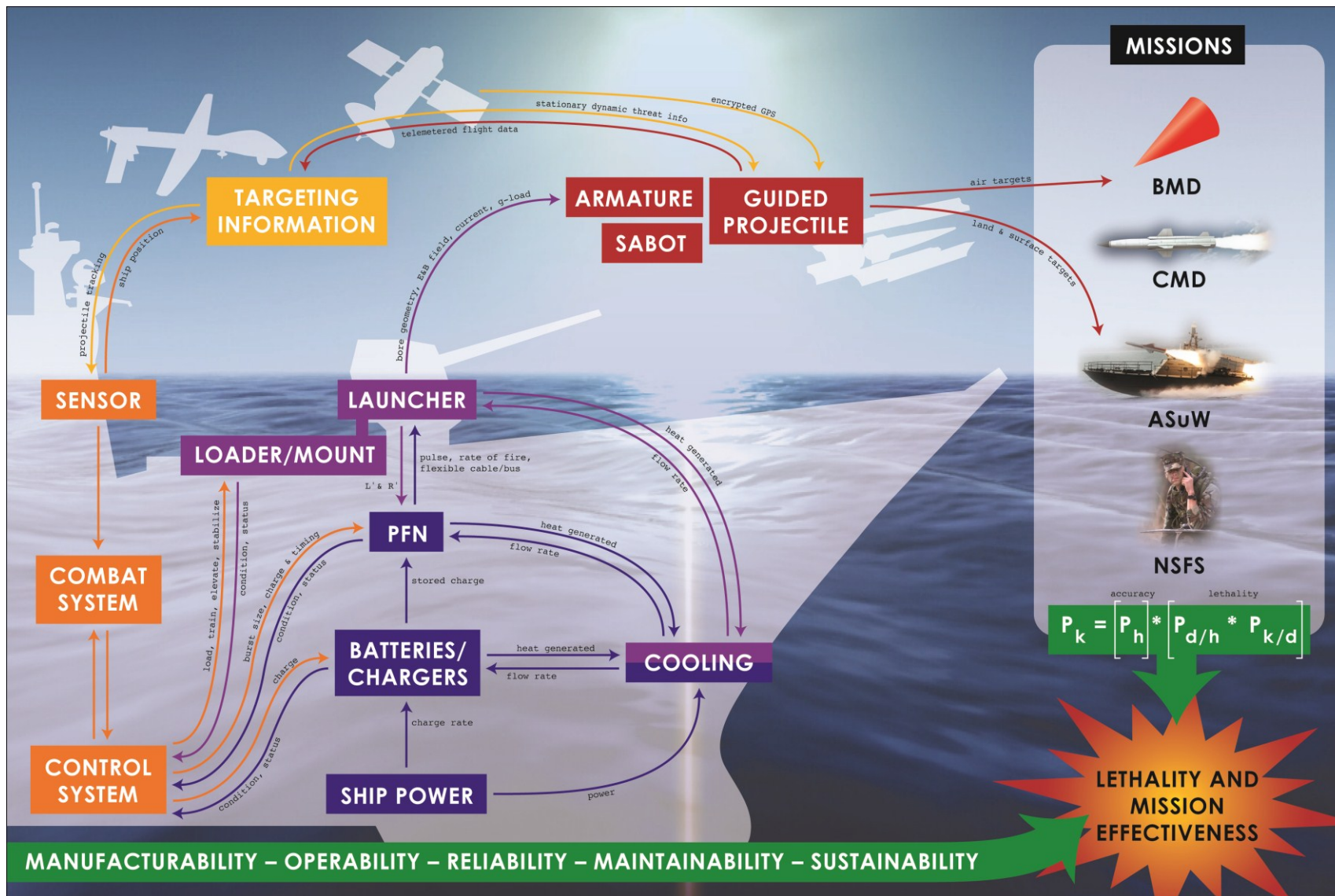
- **No Blast Overpressure**
- **Focused Fragment Pattern**
- **Minimal Collateral Damage**

UNCLASSIFIED

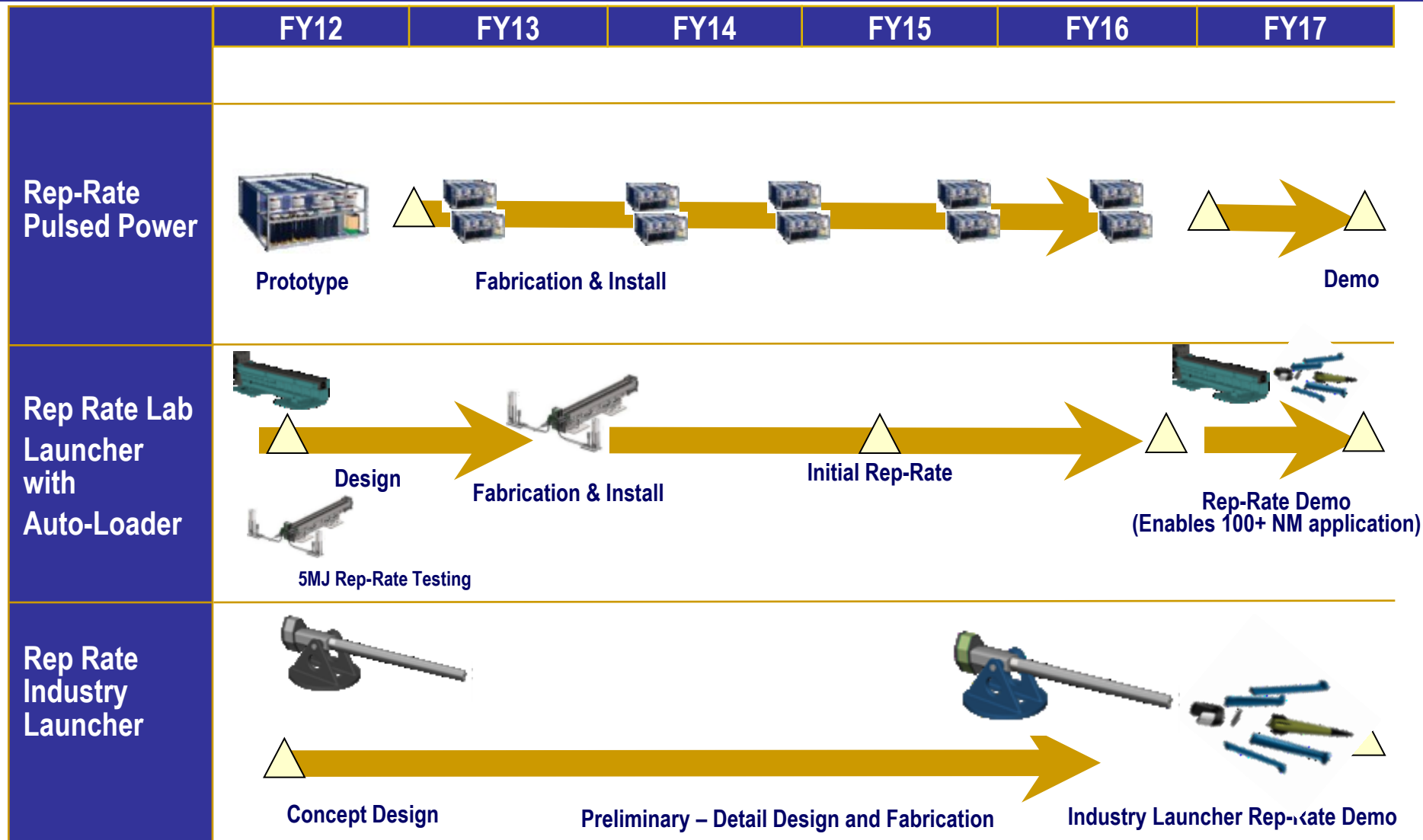


Pulsed Power at the Electromagnetic Launch Facility, Dahlgren, VA

Railgun System Integration



EM Railgun INP Phase II



INP II Focused on Rep-Rate and Thermal Management

- Naval EM Railgun is a “Navy after Next” Game Changer
- Risk Mitigation
 - Barrel Life Development
 - Advanced Containment Launchers – Competitive solutions
 - Critical Projectile Components
 - Understanding Ship and Weapons System Integration Requirements

Challenges Understood and Being Addressed