46th Annual NDIA
Gun & Missile Systems Conference
Non-Traditional Weapons I

Development of a Large Caliber Naval EM Railgun

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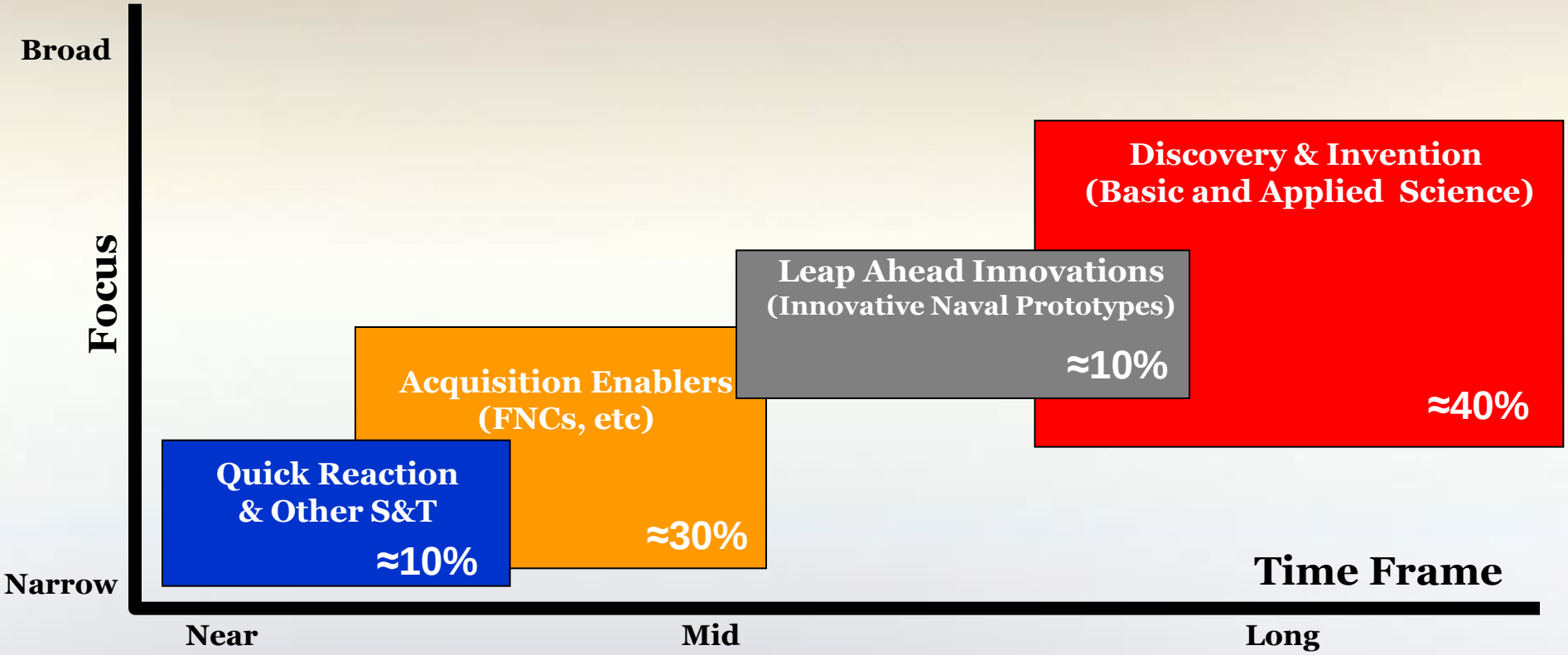
Office of Naval Research

Is this what you think of when you hear RAILGUN?

80 cm German Gun “Dora” circa 1942

THINK AGAIN!!

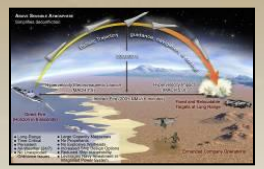
ONR Shaping S&T Investment



Innovative Naval Prototypes

INP Objective

- Explore high-risk, game-changing technologies
- Provide a venue to experiment with innovative technologies to advance the capabilities of the Warfighter
- Reduce the acquisition risk of disruptive technologies and capabilities

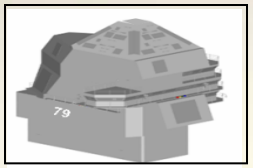


EMRG

PLUS

SBE

FEL



INTOP

Technical Approach

- Transition investments within 4 to 8 years
- Leverage previously untapped D&I investments
- Force function on the basic and applied research community
- Move the risk from acquisition ($B) back to S&T ($M)
- Accept higher technological risk than FNCs
- Cultivate significant high level interest (Executive Steering Committees from SECNAV, OPNAV, SYSCOM and S&T communities)
- Useable prototype available at completion
- Deputy PMs from acquisition PEOs to facilitate transition

Primary S&T Focus Areas

- Affordability, Maintainability, and Reliability
- Information, Analysis, and Communications
- Survivability and Self Defense

Current INP Projects

- Electromagnetic Railgun
- Sea Base Enabler
- Tactical Satellites
- Persistent Littoral Undersea Surveillance
- Free Electron Laser
- Integrated Topside

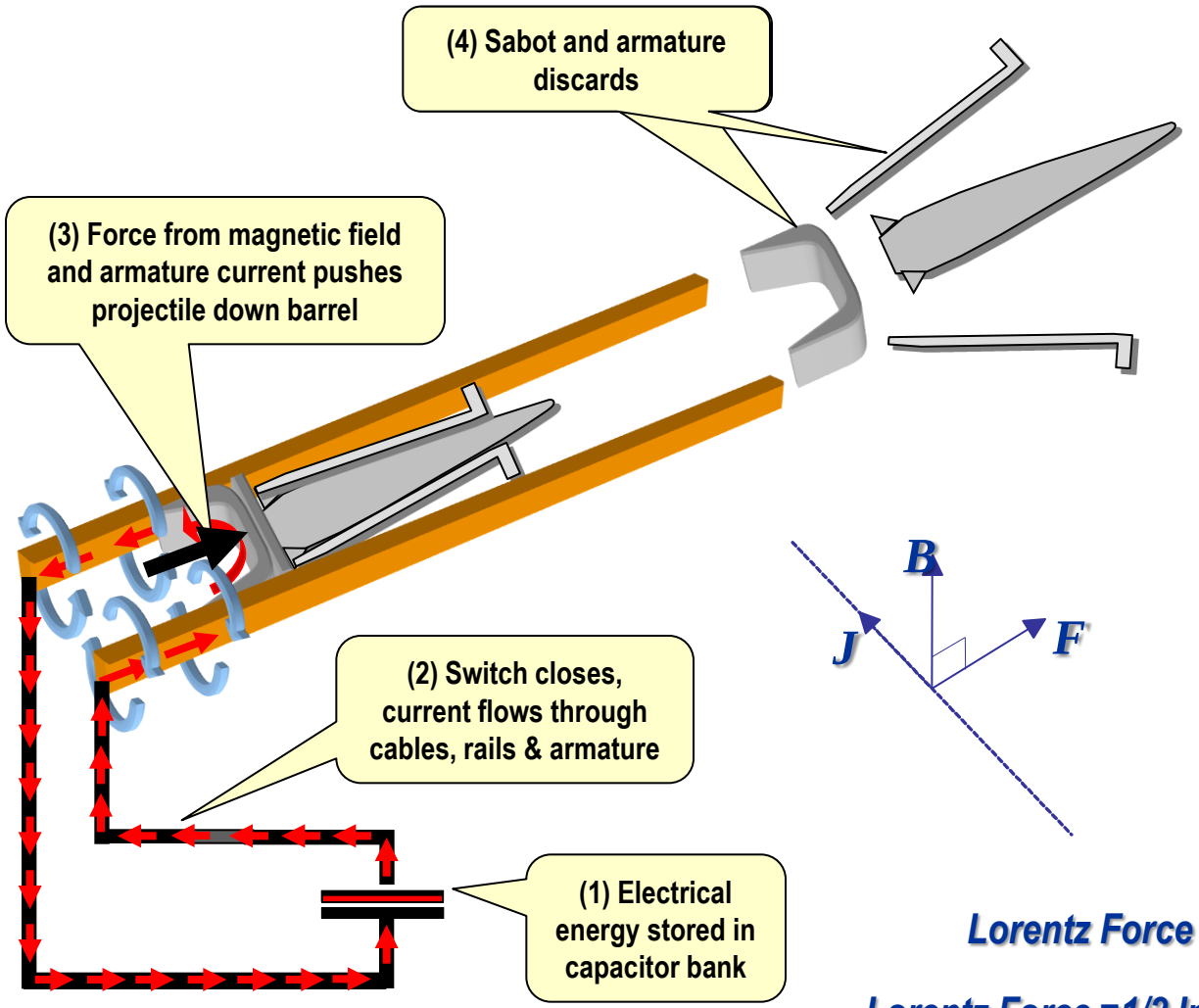
Naval Air Warfare and Weapons

Code 35

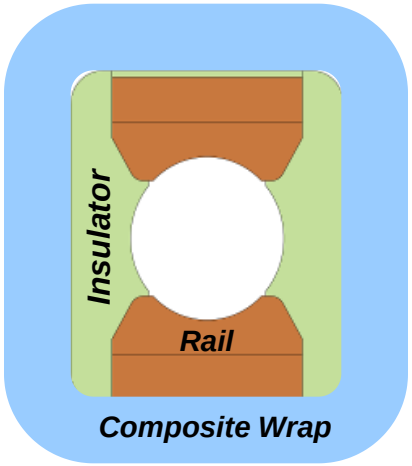
Revolutionary Research . . . Relevant Results

How Railgun Works

Operating Principle



Cross-Section



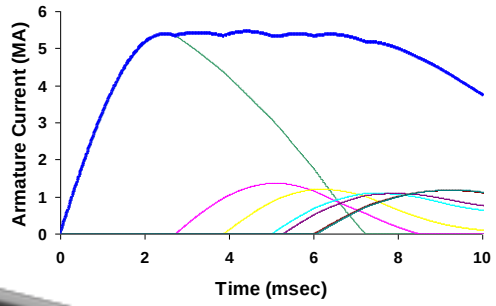
Lorentz Force = Current (J) X Magnetic Field (B)

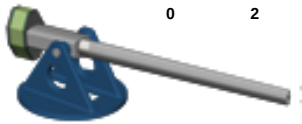
or

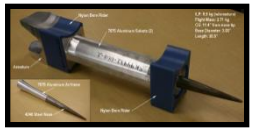
Lorentz Force =1/2 Inductance Gradient (L') * Current (I)^2

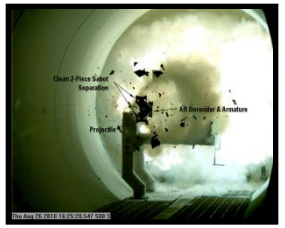
What's Non-Traditional About Naval Railgun

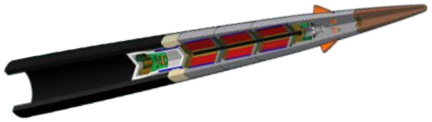
- Electrical energy vs. chemical propellants for projectile launch
  - Enables variable velocity
  - Optimized in-bore acceleration profile
- Non-electrical conducting barrel structure
- Greater launch velocities than conventional (2.5km/sec)
- Greater ranges (200+nm)
- Enables non-round bore geometries
- Ballistic trajectory with guided projectile correction
  - Endo-exo-endo
  - Aerodynamic profile
- Kinetic energy kill through dispensed fragments variable height of burst
- Enables greater ship platform modularity

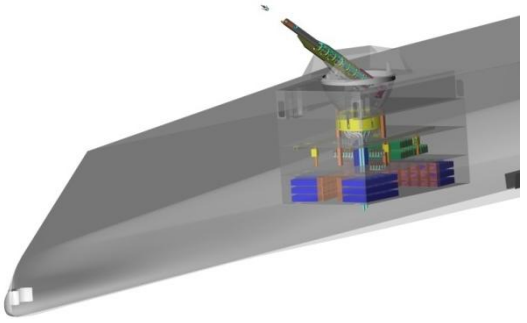






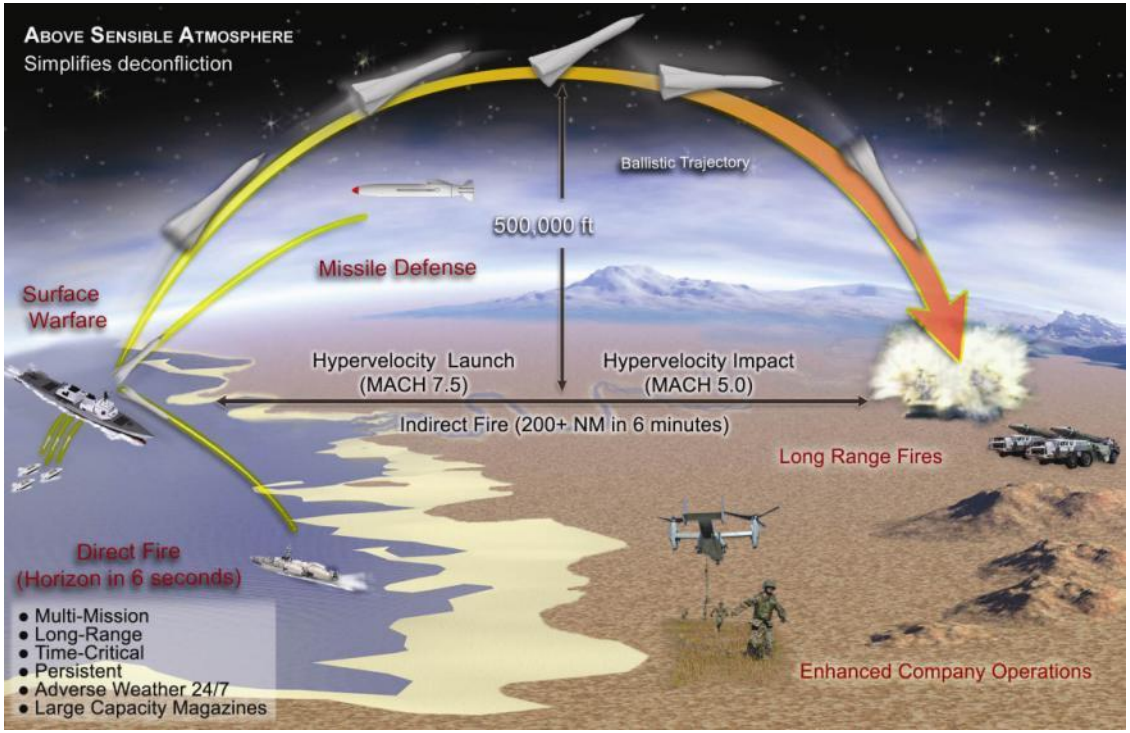






Railgun Operational Impact

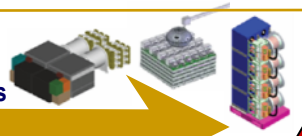
- *Wide Area Coverage*
  - Increased speed to target
  - 200+ NM
- *Accelerates operational tempo*
  - Faster attrition of enemy personnel and equipment
  - Operation timeline shifts left
- *Reduces Cost per Kill*
  - Lower Unit Cost
  - Lower handling cost
- *Enhances Safety*
  - No risk of sympathetic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



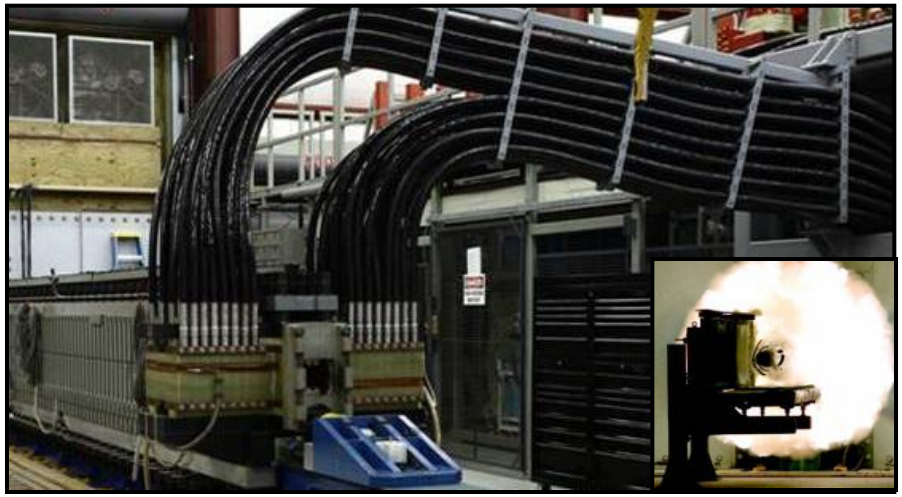
- *Multi-Mission Capability*
  - *Surface Warfare*
  - *Missile Defense*
  - *Long Range Fires*
  - *Direct Fire*
  - *ASuW*

Multi-Mission Capable for Offense and Defense

EM Railgun INP Phase I

	FY05	FY06	FY07	FY08	FY09	FY10	FY11
Milestones		Program Initiation August 2005	Initial 8MJ Test Capability	World Record Launch 10MJ	Initial 16MJ Test Capability	S&T Go No-Go Decision Point	
Launcher Bore Life Development				32MJ Lab Gun Bore Life Development →		32 MJ Launcher 100 Shot Bore Life Demo	
Advanced Containment Development	3 Concept Designs → Demo Selections		BAE  General Atomics	Technology Development and Preliminary Design →	Detail Design →	Fabrication →	32 MJ Launcher 100 Shot Bore Life Demo
Pulsed Power System Development				For Launcher Testing 100MJ Capacitor Bank →  General Atomics 		Alternative Studies →  Rep Rate Capacitor Test Bed →	Pulsed Power Recommendation
Integrated Launch Package Development	 Boeing Draper Government Concept Trades			Projectile Baseline Design & Critical Component Development → Unitary Lethality Demo	Baseline Design → Dispense Demo	Critical Component Demos	Integrated Launch Package (ILP) Demos

Progress FY05 – FY11

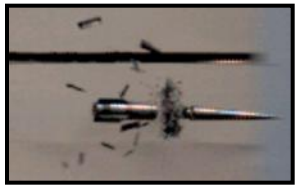


Lab Launcher

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

Revolutionary Research . . . Relevant Results

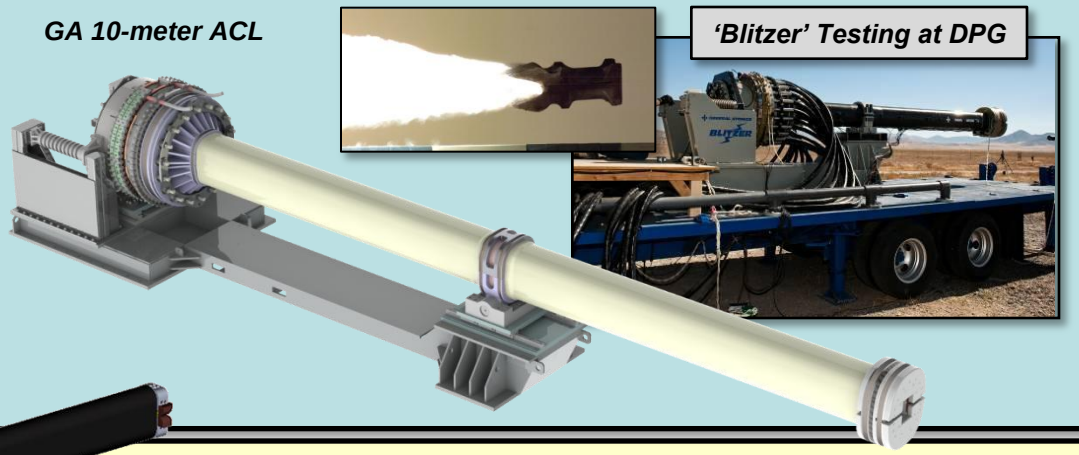
The industry developed Advanced Containment Launchers (ACLs) detailed designs are competition sensitive and each include unique materials, however they both share the following attributes:

- **Advanced composite containment designs**
- **Advanced insulator materials**

GENERAL ATOMICS

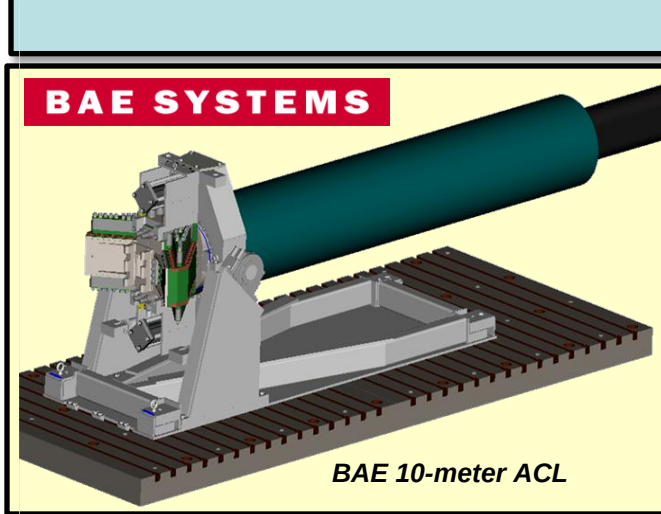
- **Subscale ACL launcher ('Blitzer') built by GA to provide risk reduction. Multiple test series have been completed at Dugway Proving Grounds (DPG), Utah**
- **Full-scale 10-meter ACL in production**
- **GA 10-meter ACL scheduled to be delivered to the Electromagnetic Launch Facility (EMLF) at NSWC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

GA 10-meter ACL



'Blitzer' Testing at DPG

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**

Videos

Distribution A:
Approved for Public Release
Distribution is Unlimited

Distribution Statement A:
Approved for Pubic Release.
Distribution is Unlimited.

EM Railgun INP Phase II

	FY12	FY13	FY14	FY15	FY16	FY17
Rep-Rate Pulsed Power	Prototype	Fabrication & Install				Demo
Rep Rate Lab Launcher with Auto-Loader	5MJ Rep-Rate Testing	Design	Fabrication & Install		Initial Rep-Rate	Rep-Rate Demo (Enables 100+ NM application)
Rep Rate Industry Launcher	Concept Design		Preliminary – Detail Design and Fabrication			Industry Launcher Rep-Rate Demo

INP II Focused on Rep-Rate and Thermal Management

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