Railgun Overview & Testing Update

NDIA Joint Armaments Conference: Unconventional & Emerging Armaments Session

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Program Manager, NSWC Dahlgren
How Railgun Works

Operating Principle

1. Electrical energy stored in capacitor bank

2. Switch closes, current flows through cables, rails & armature

3. Force from magnetic field and armature current pushes projectile down barrel

4. Sabot and armature discards

Cross-Section

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

or

Lorentz Force = 1/2 Inductance Gradient (L') * Current (I)^2
Distribution A:
Approved for Public Release
Distribution is Unlimited
Railgun Operational Impact

- **Wide Area Coverage**
  - Increased speed to target

- **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
- Thermal management techniques
- M&S – Represent interaction between bore and projectile

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

**Pulse Forming Network (PFN)**
- Energy Density
- Rep rate operation & thermal management
- Switching

**Ship Integration**
- Dynamic Power Sharing
- Space and Weight
- Thermal and EM Field Management
# EM Railgun INP Phase I

## Milestones

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>FY05</td>
<td>Program Initiation August 2005</td>
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<tr>
<td>FY06</td>
<td>Initial 8MJ Test Capability</td>
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<tr>
<td>FY07</td>
<td>World Record Launch 10MJ</td>
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<tr>
<td>FY08</td>
<td>Initial 16MJ Test Capability</td>
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<td>FY09</td>
<td>S&amp;T Go No-Go Decision Point</td>
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<tr>
<td>FY10</td>
<td>32 MJ Launcher 100 Shot Bore Life Demo</td>
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<tr>
<td>FY11</td>
<td>32 MJ Launcher 100 Shot Bore Life Demo</td>
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## Launcher Bore Life Development

- **32MJ Lab Gun Bore Life Development**

## Advanced Containment Development

- **Concept Designs**
- **BAE**
- **General Atomics**

## Pulsed Power System Development

- **For Launcher Testing 100MJ Capacitor Bank**
- **General Atomics**

## Integrated Launch Package Development

- **Boeing**
- **Draper**
- **Government**
- **Concept Trades**
- ** Projectile Baseline Design & Critical Component Development**
- **Baseline Design**
- **Unitary Lethality Demo**
- **Dispense Demo**
- **Critical Component Demos**
- **Integrated Launch Package (ILP) Demos**

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Distribution A: Approved for Public Release Distribution is Unlimited
Progress FY05 – FY11

- Muzzle energy:
  - From 6MJ to 32MJ
- Bore Life
  - From 10s to 100s
  - Multiple configurations & materials
- Industry Launcher Prototypes
  - From concept to hardware
- Pulsed power
  - 2.5X increase in energy density
  - Multi-shot capable design
- Projectile
  - From slugs & sand catch
  - Flight bodies on open range
- Mission
  - From Land Attack
  - To Multi-Mission Initiative
Industry Launcher Prototypes

BAE SYSTEMS
U.S. NAVAL ELECTROMAGNETIC RAILGUN PROTOTYPE LAUNCHERS

GENERAL ATOMICS
Distribution Statement A:
Approved for Public Release.
Distribution is Unlimited.
HE versus KE Projectiles

High Explosive (HE) Warhead

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

Kinetic Energy (KE) Projectile

- No Blast Overpressure
- Focused Fragment Pattern
- Minimal Collateral Damage
Projectile Dispense

Gun Launch
Pulsed Power at the Electromagnetic Launch Facility, Dahlgren, VA
## EM Railgun INP Phase II

### Rep-Rate Pulsed Power

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<th>FY14</th>
<th>FY15</th>
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<td>Prototype</td>
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<td>Fabrication &amp; Install</td>
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<td>Demo</td>
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### Rep Rate Lab Launcher with Auto-Loader

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<tr>
<td>Initial Rep-Rate</td>
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<tr>
<td>Rep-Rate Demo (Enables 100+ NM application)</td>
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### Rep Rate Industry Launcher

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<td>Concept Design</td>
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<td>Preliminary – Detail Design and Fabrication</td>
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<td>Industry Launcher Rep-Rate Demo</td>
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**INP II Focused on Rep-Rate and Thermal Management**
Summary

• 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
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