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?

THINK AGAIN!!

80 cm German Gun “Dora” circa 1942
ONR Shaping S&T Investment

Focus

Broad

Near

Quick Reaction & Other S&T
≈10%

Mid

Acquisition Enablers (FNCs, etc)
≈30%

Leap Ahead Innovations (Innovative Naval Prototypes)
≈10%

Discovery & Invention (Basic and Applied Science)
≈40%

Narrow

Time Frame

Long

Distribution A: Approved for public release; distribution is unlimited
## 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

## 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
ONR Code 35

Naval Air Warfare and Weapons

Code 35
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 = \( \frac{1}{2} \) 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

### Milestones

<table>
<thead>
<tr>
<th>FY05</th>
<th>FY06</th>
<th>FY07</th>
<th>FY08</th>
<th>FY09</th>
<th>FY10</th>
<th>FY11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Initiation August 2005</td>
<td>Initial 8MJ Test Capability</td>
<td>World Record Launch 10MJ</td>
<td>Initial 16MJ Test Capability</td>
<td>S&amp;T Go No-Go Decision Point</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Launcher Bore Life Development

- 32 MJ Launcher 100 Shot Bore Life Demo
- 32 MJ Lab Gun Bore Life Development

### Advanced Containment Development

- 3 Concept Designs
- Demo Selections

- BAE
- General Atomics

- Technology Development and Preliminary Design
- Detail Design
- Fabrication

### Pulsed Power System Development

- For Launcher Testing 100MJ Capacitor Bank
- Alternative Studies
- Rep Rate Capacitor Test Bed
- Pulsed Power Recommendation

- General Atomics

### Integrated Launch Package Development

- Projectile Baseline Design & Critical Component Development
- Baseline Design
- Unitary Lethality Demo
- Dispense Demo
- Critical Component Demos
- Integrated Launch Package (ILP) Demos

- Boeing
- Draper
- Government

- Concept Trades
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
  - 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
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**
- 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 10-meter ACL**
- 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
Gun Launch

Distribution Statement A:
Approved for Public Release.
Distribution is Unlimited.
EM Railgun INP Phase II

<table>
<thead>
<tr>
<th>Rep-Rate Pulsed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prototype</td>
</tr>
<tr>
<td>Fabrication &amp; Install</td>
</tr>
<tr>
<td>Demo</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rep Rate Lab Launcher with Auto-Loader</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
</tr>
<tr>
<td>Fabrication &amp; Install</td>
</tr>
<tr>
<td>Initial Rep-Rate</td>
</tr>
<tr>
<td>Rep-Rate Demo (Enables 100+ NM application)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rep Rate Industry Launcher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept Design</td>
</tr>
<tr>
<td>Preliminary – Detail Design and Fabrication</td>
</tr>
<tr>
<td>Industry Launcher Rep-Rate Demo</td>
</tr>
</tbody>
</table>

INP II Focused on Rep-Rate and Thermal Management
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