



Program Objective



**Demonstrate
a leap-ahead EM Gun armament
system that proves the maturity of
the technology for
future combat systems**

Report Documentation Page		
Report Date 26032001	Report Type N/A	Dates Covered (from... to) -
Title and Subtitle Demonstrate a leap-ahead EM Gun armament system that proves the maturity of the technology for future combat systems	Contract Number	
	Grant Number	
	Program Element Number	
Author(s)	Project Number	
	Task Number	
	Work Unit Number	
Performing Organization Name(s) and Address(es) Army Research Laboratory	Performing Organization Report Number	
Sponsoring/Monitoring Agency Name(s) and Address(es) NDIA (National Defense Industrial Association 2111 Wilson Blvd., Ste. 400 Arlington, VA 22201-3061	Sponsor/Monitor's Acronym(s)	
	Sponsor/Monitor's Report Number(s)	
Distribution/Availability Statement Approved for public release, distribution unlimited		
Supplementary Notes Proceedings from National Summit on U.S. Defense Policy: Acquisition, Research, Test and Evaluation, 26-30 March 2001 sponsored by NDIA.		
Abstract		
Subject Terms		
Report Classification unclassified	Classification of this page unclassified	
Classification of Abstract unclassified	Limitation of Abstract UU	
Number of Pages 11		

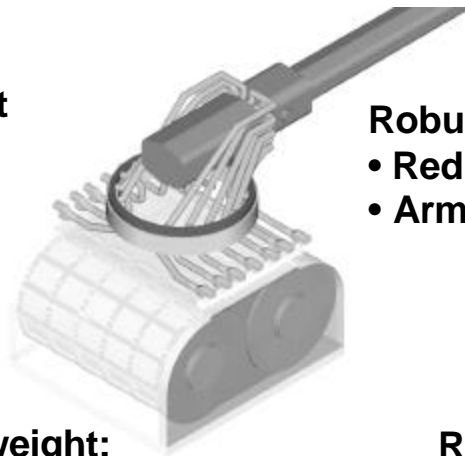
Army EM Gun Program Challenges



Pulsed Power

Increased energy density of rotating machines:

- Material strength
- Efficiency
- Thermal management



Launch Package

Robust lethality against future threats:

- Reduced parasitic mass
- Armature operation

Switching

Reduced volume and weight:

- Si & SiC development
- Efficient packaging
- Thermal management

Robust Launcher

Robust “fieldable” launcher:

- Wear life - material hardness
- Efficiency - energy recovery
- Thermal management - cooling

Current armament system is ~3 tons heavier than equivalent ETC system

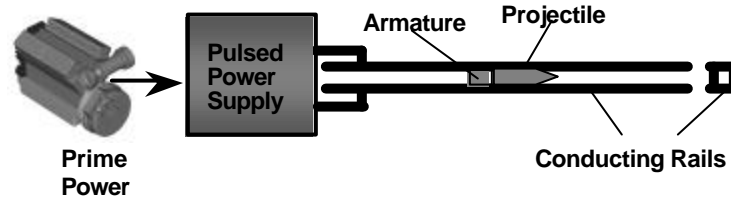
Significant Engineering Challenges - Physics Works

Army EM Gun Program Advantages



3 Orders of Magnitude Reduction
in Signature

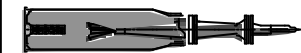
Stealth Launch



Replaces propellant (chemical energy)
with
mechanical energy & electrical energy



EM 90mm



ETC 120mm

1/3 the volume; 1/2 the weight

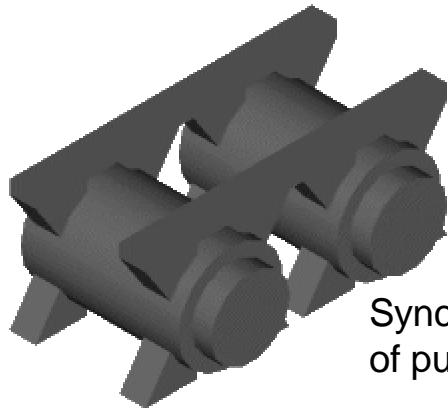
Improved Sustainment

- Improved lethality from adjustable velocity (including hypervelocity)
- Stealth launch
- Reduced logistics - eliminate chemical propellant; smaller weight/volume rounds
- Improved survivability - eliminate chemical propellants
- Synergism with system: electric protection, electric propulsion, electric weapon
- Shorter time of flight - accuracy
- Lethal from muzzle to extended ranges

A lethal armament for future combat systems

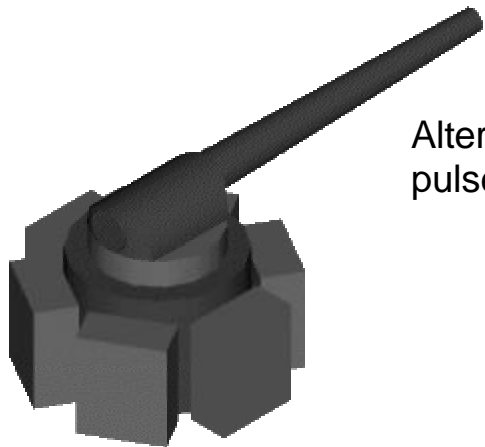
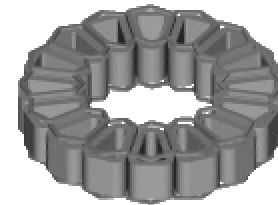
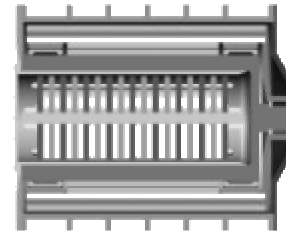
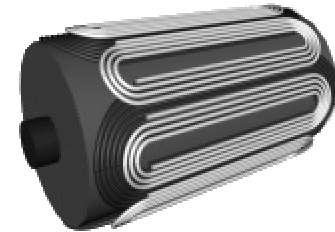
Pulsed Power Research Program **ARL**

The Pulsed Power research effort is focusing on the following critical tasks:



Synchronization and control
of pulsed alternator pairs.

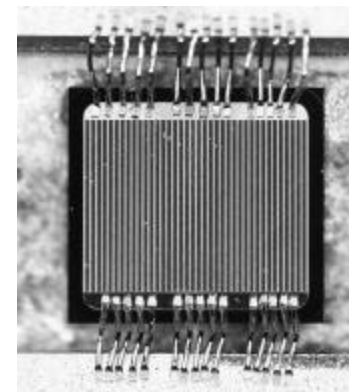
Analysis and simulation of
pulsed alternator topologies
(disk, drum, cup, ...).



Alternative (Non-rotating)
pulsed power systems.

Advanced switching concepts:

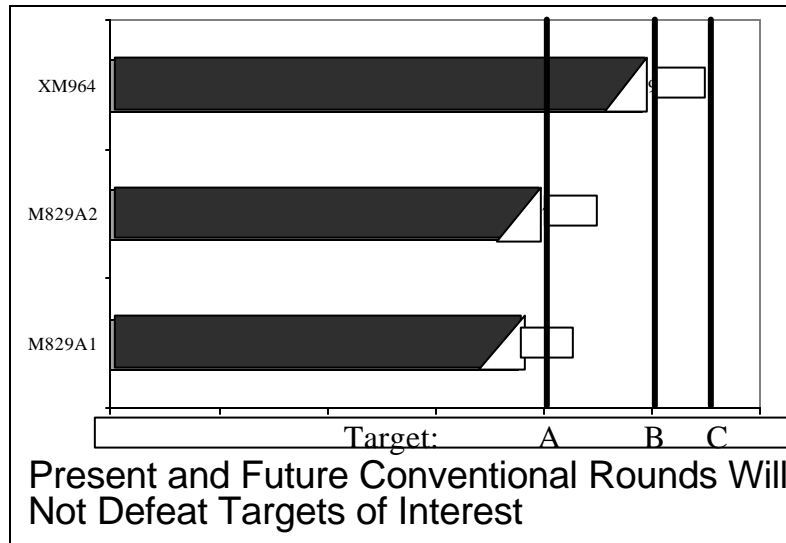
- Silicon Carbide
- Optical Triggering
- Opening Switches



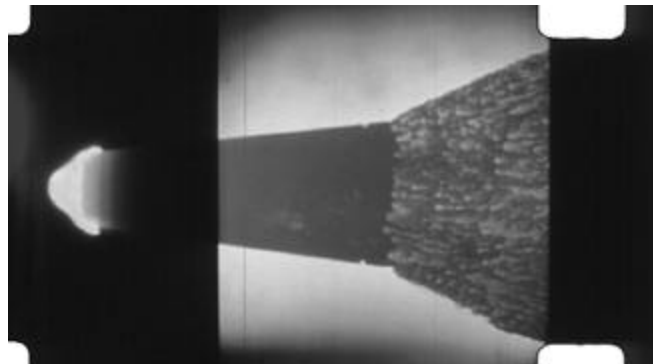
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Hypervelocity Lethality Accomplishments



IAT Novel Kinetic Energy Penetrator (NKEP)
Defeated Target at Low Impact Energy



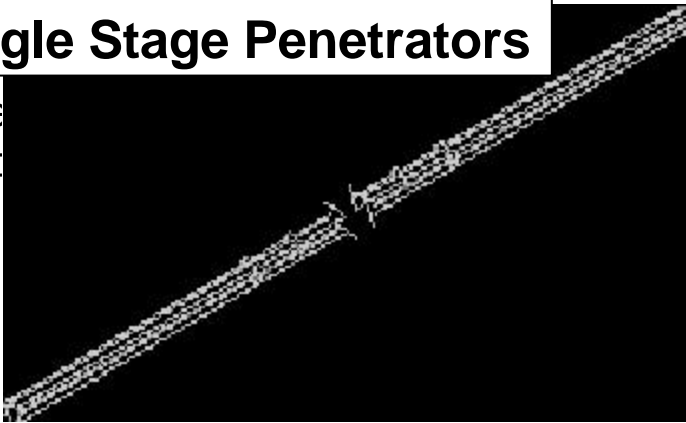
IAT has Developed Analytic and Experimental
Methodology to Solve Ablation Problem

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Hypervelocity Lethality Plans **ARL**

Single Stage Penetrators

Ne
Inc

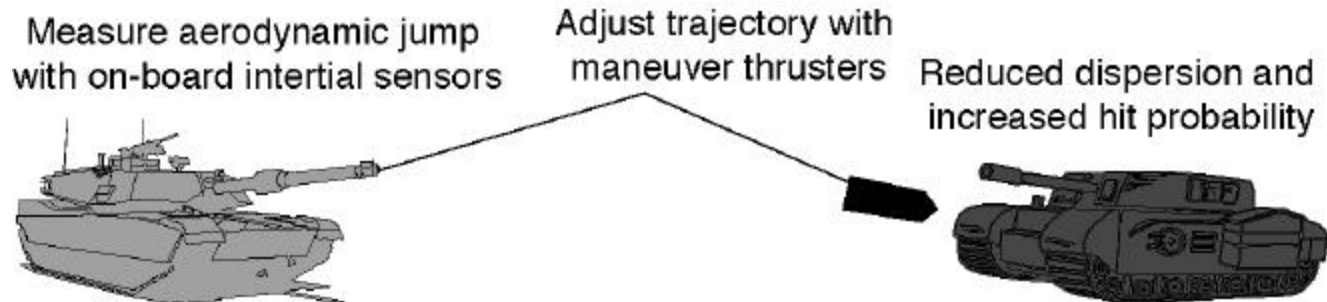


Extending Penetrators



New geometries and optimization studies.

Guidance & Control



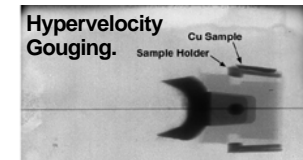
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Progress with Hypervelocity Launch



- **Hypervelocity Gouging:** A major show stopper identified in 1995 has been resolved.

- We now have a scientific understanding of the phenomenon and predictive capability.
- Robust engineering solutions involve use of hard cladding.
- Gouge-free railgun operation demonstrated to 2.85 km/s.



Muzzle radiograph from experiments to measure gouging threshold velocities of various materials.

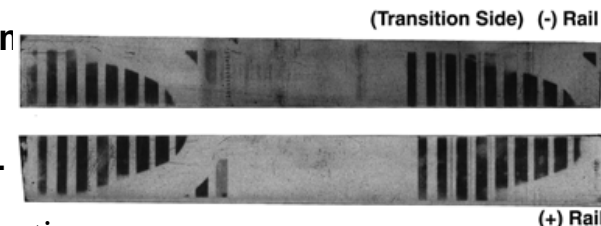
- **Muzzle Signature Suppression** can be performed effectively using an Inductive Muzzle Shunt.

- Three generations of shunts tested at IAT.
- EM Spectral measurements demonstrated the possibility of operation EML in ultra-low signature mode.
- Significantly less EM than conventional guns.
- Current research at IAT
 - Use of Inductive Shunt to recover energy from EML
 - Shunt armature interaction to stabilize armature.



- **Transition to Arcing Contact** is a difficult problem is within reach (~2years).

- We understand the phenomenon (multiple cause identified) Modeling capabilities being developed.
- Actively exploring design solution.



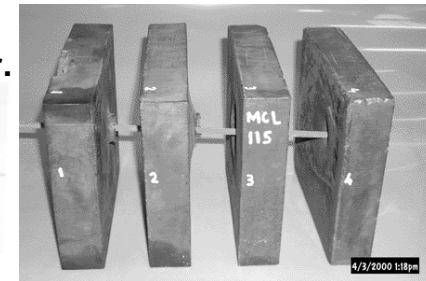
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Progress with Hypervelocity Launch



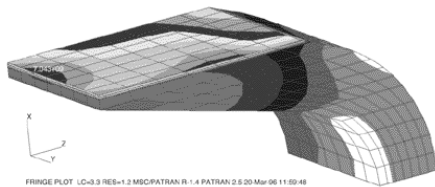
- Integrated Launch Package Development
 - Tungsten Rods successfully launched from our EM launcher.



- Thermal Structural Modeling

- EMAP3D

- (1995) Only program to solve Coupled EM-Thermal diffusion w/sliding electrical contact.
- (1997) One way coupling to DYNA3D allows large deformation thermo elastic plastic.
- 1999 -2001 Parallelization of EMAP3D on Beowolf PC Cluster made it a comprehensive design and detail analysis tool.
- 2001 Plasticity Module expand EMAP3D application further.

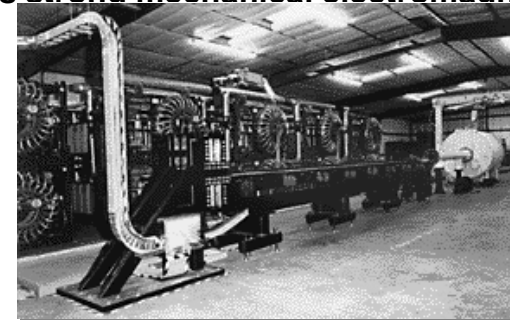


- Hybrid BE PE Formulation facilitates strong mechanical electromagnetic coupling,

- Experimental Facilities

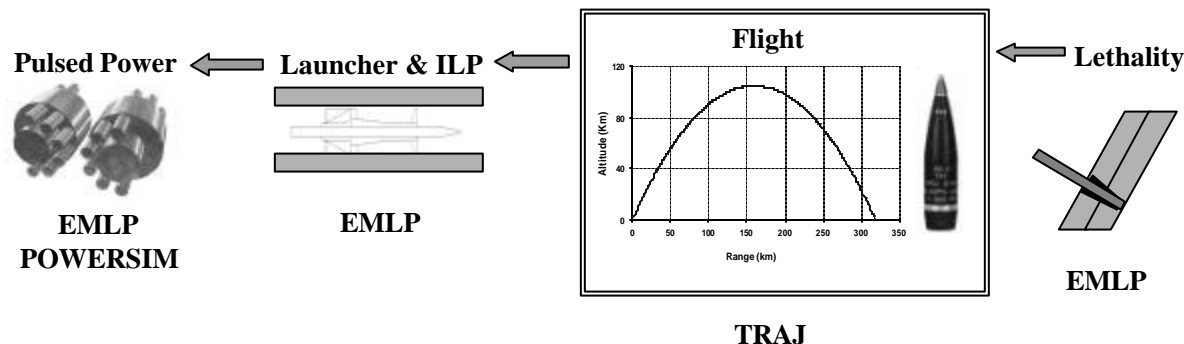
- Largest operational EM research facility, 13MJ Power Supply
- Over 250 test supporting EML research
- Upgrade planned for 2001 with double the muzzle energy and add two new launcher

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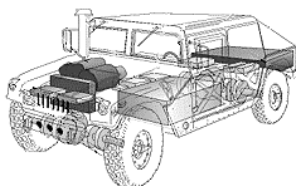


Systems & Technology Integration

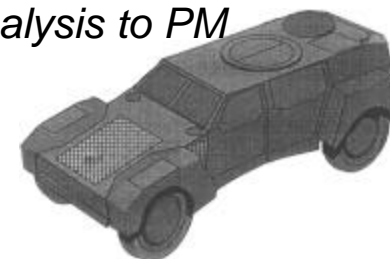
EM Gun System Performance Analysis – Software Development



Vehicle Performance – POWERSIM Model validated with Hybrid Electric HMMWV tests *



- **DARPA Support***
- **CHPS** - IMPACT Toolbox completed & made available to government and industry
- **RSTV** - Provided modeling and technical analysis to PM





Army EM Gun Program



- Program Management
- Technical Support



- Basic 6.1 Research
- Integral Member of ARL Program Office/Team



- Technology Development
- Technology Component Development
- Technology Integration



Summary



- **Major Leap Ahead Technology for the Future**
- **Offers Enhanced Lethality & Survivability for Future Combat Systems**
- **Technology is sufficiently mature to move forward with a demonstration program**
- **May not meet timeline for FUE but should be a key technology for Block I upgrade**

