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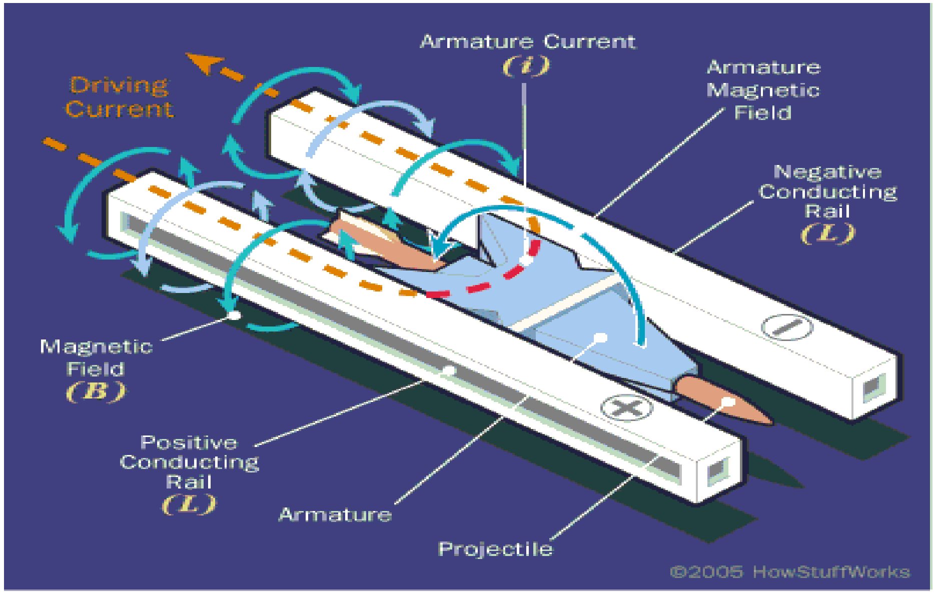
भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

# Optimal utilization of a Rail gun

-Nagaraj R Mahajan
Patel Shabaz Basheer
Zafar Ali Khan

- ***Rail gun*** - Electrically powered gun that accelerates a conductive projectile along magnetic metal rails.




- Military applications-Weapons with no explosives.
- Space applications-Non rocket space launch.

Cheap and efficient.

# Issues

- Physical Limitations
- Velocity Skin Effect
- Friction Losses
- Magnetic Flux Leakage
- Plasma restrike
- Electro migration

# Limitation on Current Density

- Melting point of material puts limitation on current density.
- Assumptions-Input energy is used to drive the armature and in heat dissipation.
- Equations

$$P = i^2 R = i^2 \frac{\rho(2x + a)}{A} \qquad x = \frac{1}{2}\left(\frac{Bia}{m_0}\right)t^2$$

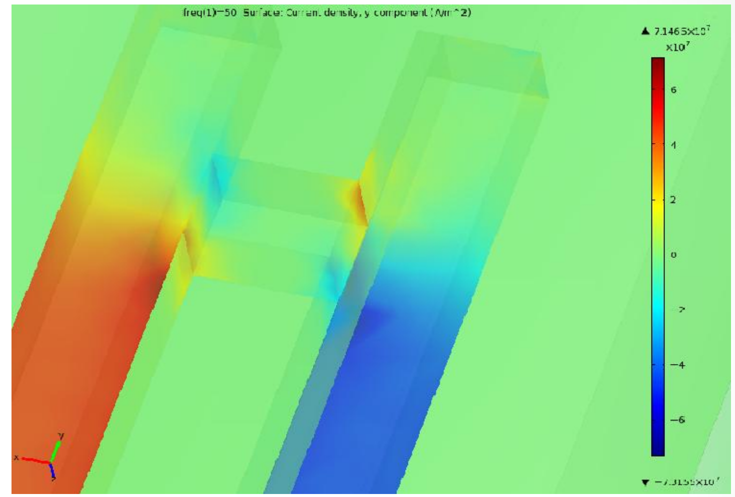
$$E = (2m_r s_r + m_0 s_a)\delta\theta$$

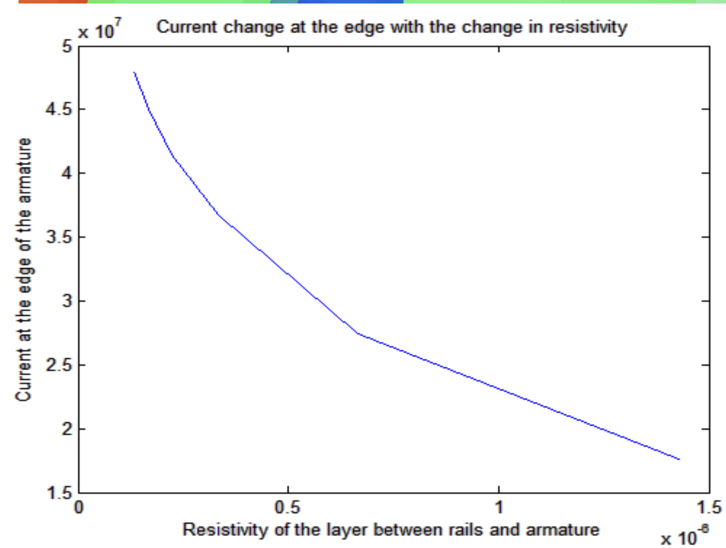
- Solving these equations yields

$$J = \frac{i}{A} = \left[\frac{\sqrt{2Ba}\,(2m_r s_r + m_0 s_a)\delta\theta}{\sqrt{Am_0}\,(\frac{4}{3}\rho_r L^{3/2} + 2\rho_a a L^{1/2})}\right]^{2/3}$$

# Velocity Skin Effect

- Major reason for causing damage to the gun
- Result of sliding contact between armature and guns.
- Spike in current density at contact that leads to melting
- Solution-Addition of an additional layer of high resistive material.
- Reduces magnitude of current density  as well as removes contact of between materials.



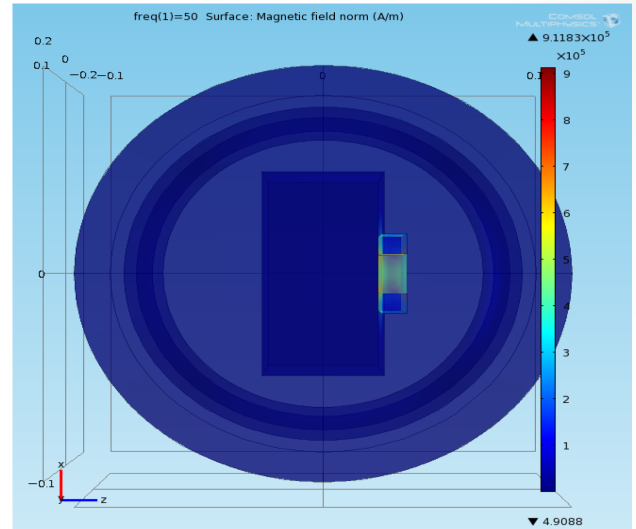


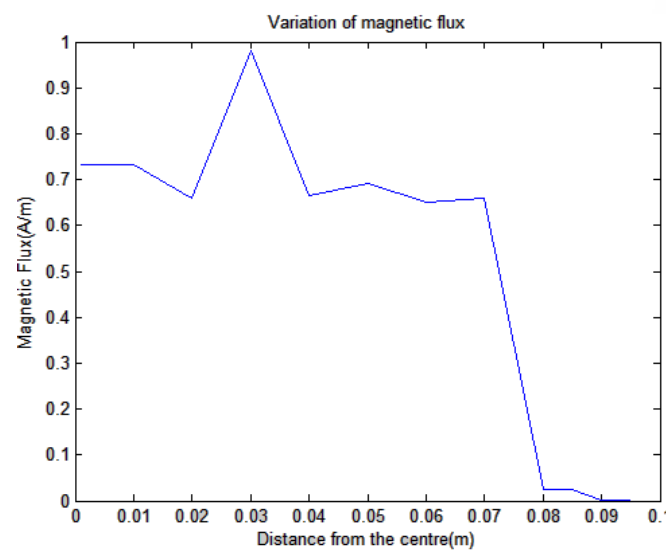
# Magnetic levitation

- Friction between armature and insulated base results in wear and tear and also decreases the projectile velocity.
- Solution-Additional external magnetic field that result in an upward force.
- Results in armature levitation by counter balancing weight and reducing the contact forces.

# Flux Leakage

- Magnetic flux leakage affects operation of circuits in the vicinity of the rail gun.
- Solution-Introduce a magnetic wrap around the rail gun to restrict the field inside the wrap.
- Wrap was chosen to be Nickel A because of its low skin depth.



# Thank You