



# E/M Launchers for Cansats

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# CURRENT SITUATION

- ❖ Currently, payloads are transported to the Earth orbit or deep into the space with rockets.
- ❖ In rockets, chemical energy is consumed to increase the kinetic energy of the exhaust gases.
- ❖ But this technology has some shortcomings.

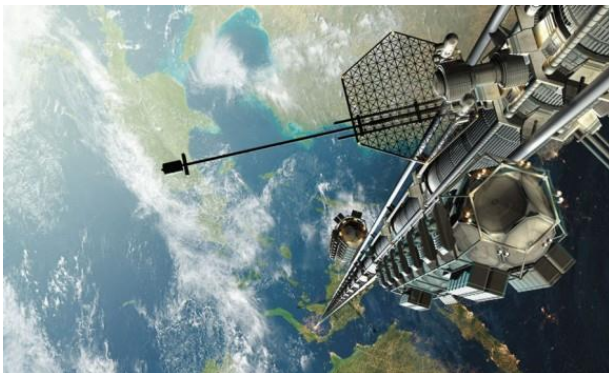


# ROCKETS

- ❖ First of all, transportation with rockets is quite expensive. It is estimated that the current cost of payload launching into LEO orbit is around \$50000/kg.
- ❖ Secondly, building rockets capable to reach space requires high technology and complicated industrial facilities.
- ❖ Next, exhaust plumes from the rocket engines are generally harmful to the launch site environment and ozone layer.
- ❖ Finally, the exhaust speeds of the gases are limited by the speed of the sound of the propellant medium

# NEW IDEAS

- ❖ To overcome these difficulties, new solutions are unveiled.
- ❖ Space elevator, laser and electromagnetic based launchers are proposed as the next generation satellite launchers
- ❖ Currently it can be said that, studies are mostly intensified on the electromagnetic launchers (EMLs) to transport payloads into the space.



<http://www.universetoday.com/105441/what-is-a-space-elevator/>

## The Laser Launch Concept

Launch many small payloads on demand -- up to 10 per hour

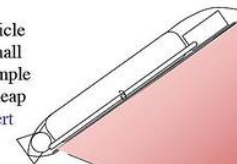
Vehicle

- Small
- Simple
- Cheap
- Inert

**Leave The Hard Parts On The Ground!**

Laser and Beam Projector

- Big
- Heavy
- Expensive
- STATIONARY



4 **30,000 launches per year x 100 kg = 3000 Metric tons per year!!**

**Rule of Thumb: 1 kg of payload per MW of laser**

<http://nextbigfuture.com/2007/05/lasers-and-magnetic-launch-for-cheap.html>

# EML

- ❖ Using EML, current payload transportation cost can be decreased dramatically as low as \$600/kg .
- ❖ Moreover, EML does not produce harmful exhaust gases.
- ❖ Finally, experimental studies show that muzzle velocities between 2 and 3 km/s can be reached with current technology.
- ❖ To take advantage of this new method, many programs are started to construct electromagnetic launchers as early as 1980s mostly with military purposes.



# SMALL SCALE CANSAT LAUNCHER

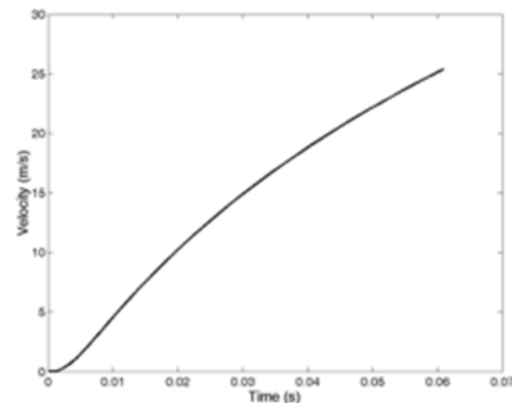
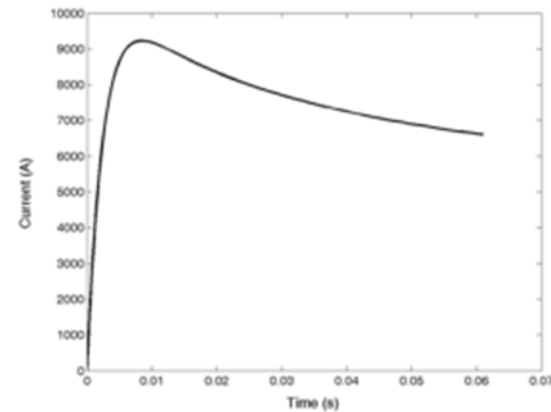
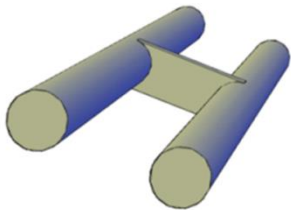
- \* We want to propose a discussion topic about how to design an EML to be capable of launching pico satellites ( $m < 1$  kg) into LEO.
- \* Or maybe a small scale EML can be built just to send Cansats to an altitude of a couple of 100 meters for university students.



[http://en.wikipedia.org/wiki/Non-rocket\\_spacelaunch#mediaviewer/File:Launch\\_ring.jpg](http://en.wikipedia.org/wiki/Non-rocket_spacelaunch#mediaviewer/File:Launch_ring.jpg)

# SIMPLE EXAMPLE

- \* One Dimensional Equation of Motion
- \* Electric Circuit Equation
- \*  $M=0.037$  Kg
- \*  $I=10000$  Ampere
- \*  $L=1$  m
- \* A muzzle velocity of 26 m/s is obtained.



# BARRIERS

- \* Power supply
  - \* Condensators
  - \* Batteries
  - \* Homopolar generators
- \* Fast switching circuits
- \* Friction between rail and armature
- \* Metal erosion