E/M Launchers for Cansats Discussion Group 6

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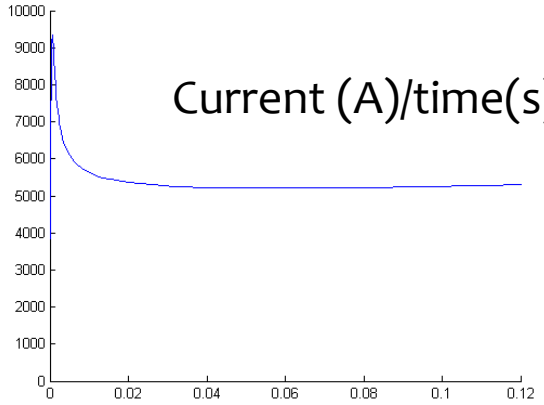
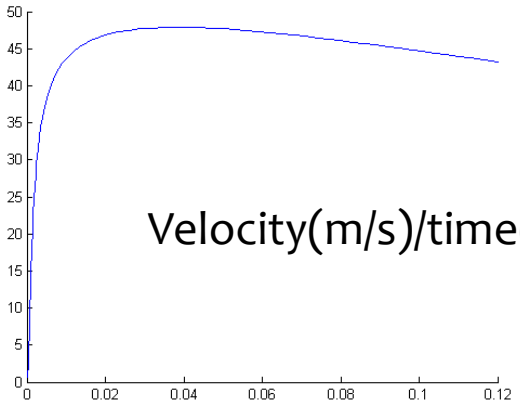
Student Project

* Case 1:
* Altitude=100 m
* L=5 m
* V_i=44 m/s
* a=20 G

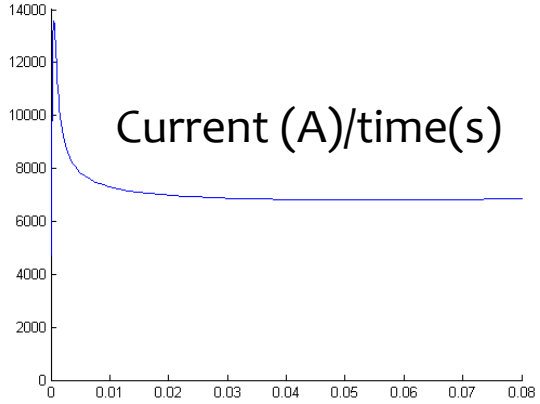


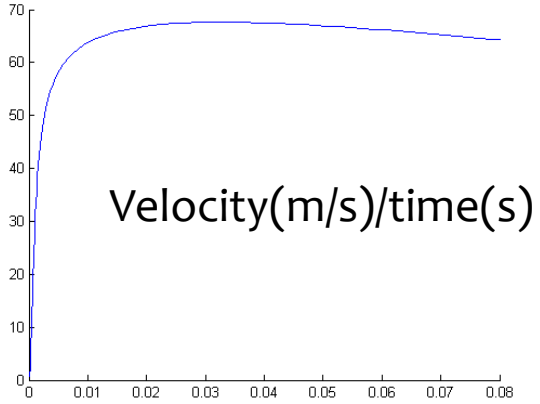
Current (A)/time(s)



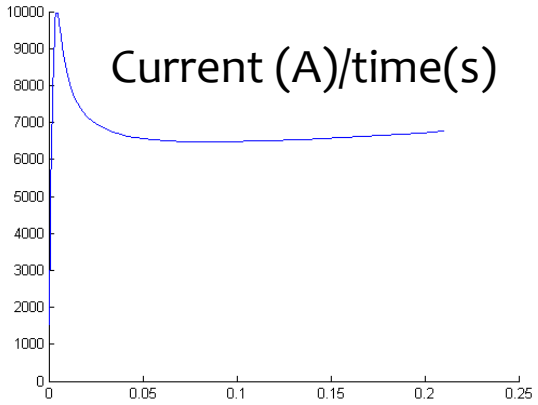
Velocity(m/s)/time(s)

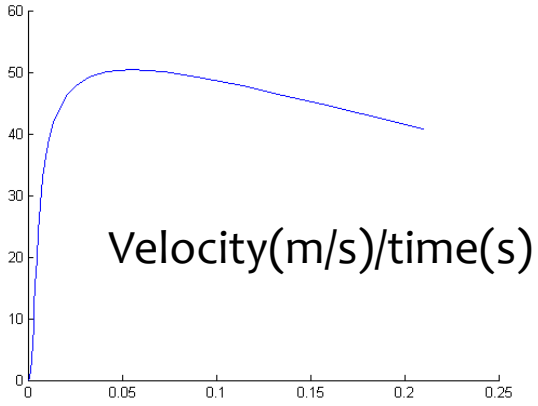
* Case 2:
* Altitude=200 m
* L=5 m
* Vi=63 m/s
* a=40 G



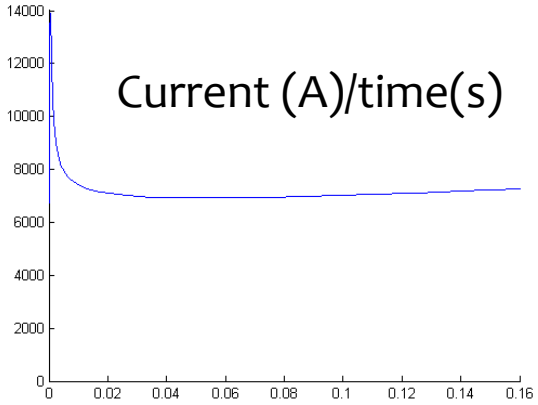


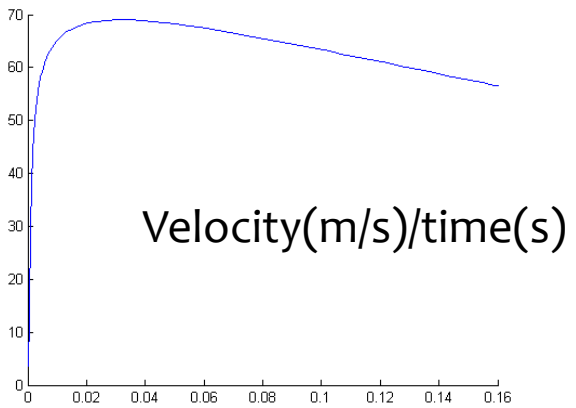
* Case 3:
* Altitude=100 m
* L=10 m
* Vi=44 m/s
* a=10 G





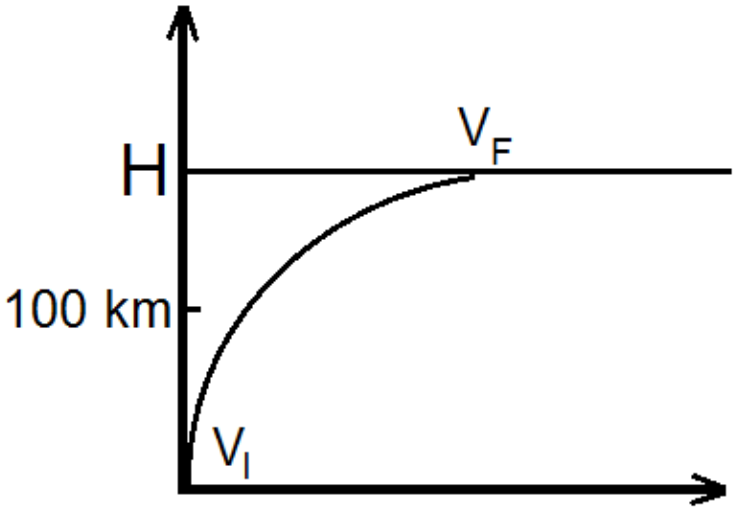
* Case 4:
* Altitude=200 m
* L=10 m
* Vi=63 m/s
* a=20 G





Real Project
Replacement of the Rocket's First Stage

* H=200 km
* m=1 kg
* V_F=7.77 km/s
* V_I=9.7 km/s
* Lenght of Launcher 4-5 km
* E_k=1.5 GJ (50% efficiency)
* Acceleration time=48 s a=20 G
* Travel time=97 s
* P=15 MW



Discussion Group 6

* Thank you very much

CURRENT SITUATION

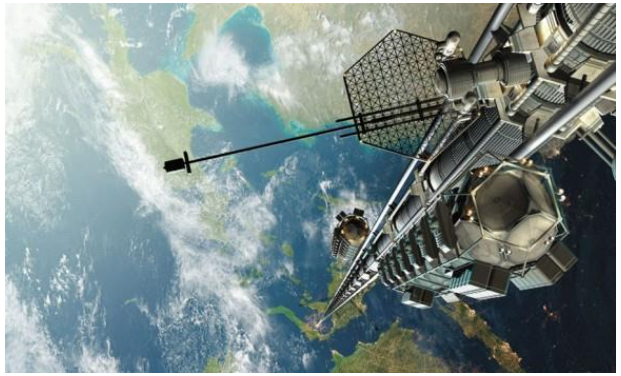
- Currently, payloads are transported to the Earth orbit or deep into the space with rockets.
- In rockets, chemical energy is consumed to increase the kinetic energy of the exhaust gases.
- But this technology has some shortcomings.

ROCKETS

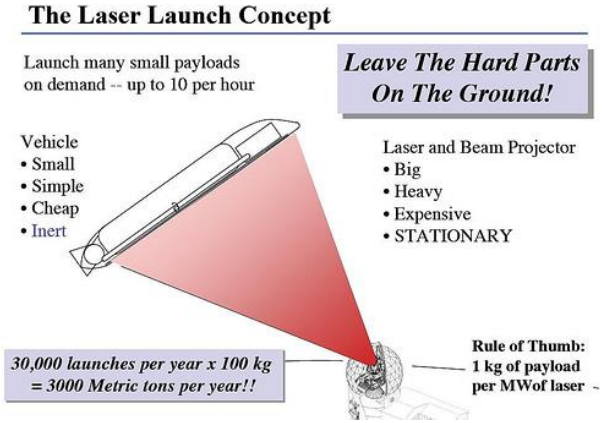
- First of all, transportation with rockets is quite expensive. It is estimated that the current cost of payload launching into LEO orbit is around $50000/kg.
- Secondly, building rockets capable to reach space requires high technology and complicated industrial facilities.
- Next, exhaust plumes from 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/



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.

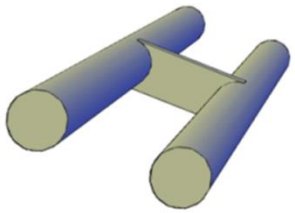
SMALL SCALE CANSAT LAUNCHER

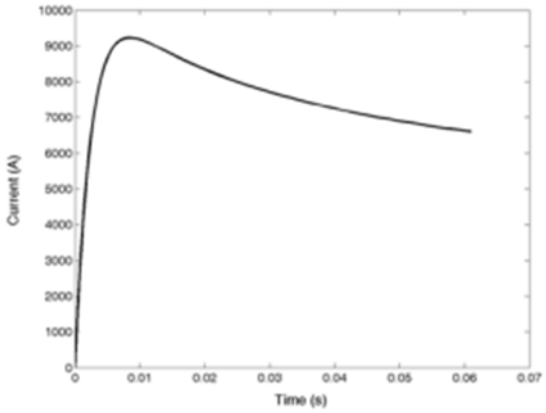
* We want to propose a discussion topic about how to design an EML to be capable of launching pico satellites (m<1 kg) into LEO.
* Or maybe a small scale EML can be built just to send Cansats to an altitude of a couple of 100 meters for university students.

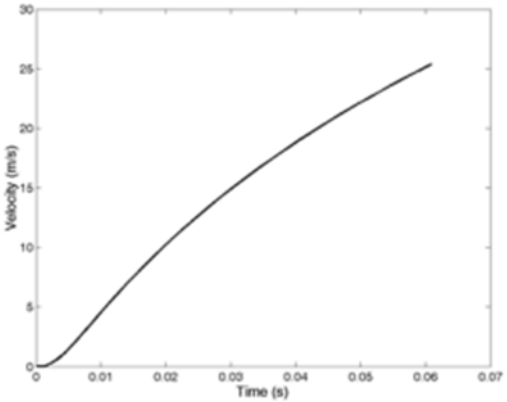
http://en.wikipedia.org/wiki/Non-rocket_spacelaunch#mediaviewer/File:Launch_ring.jpg

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