



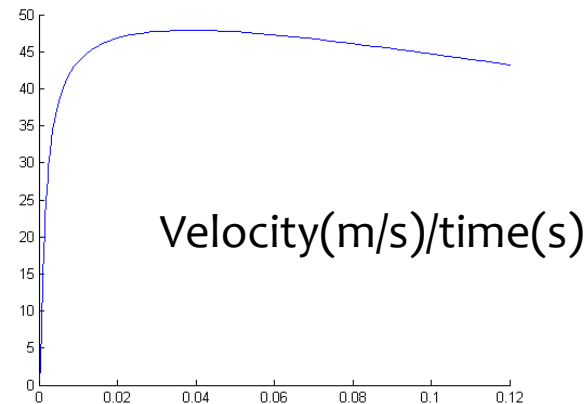
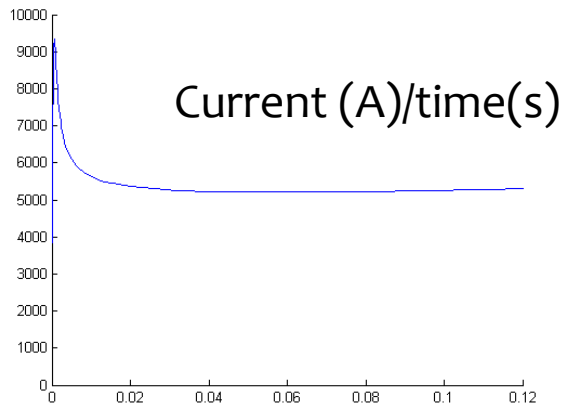
E/M Launchers for Cansats

Discussion Group 6

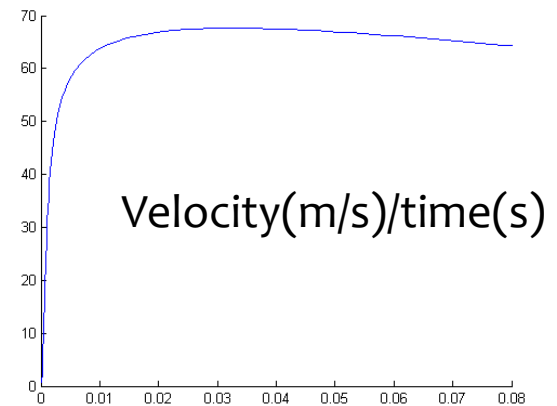
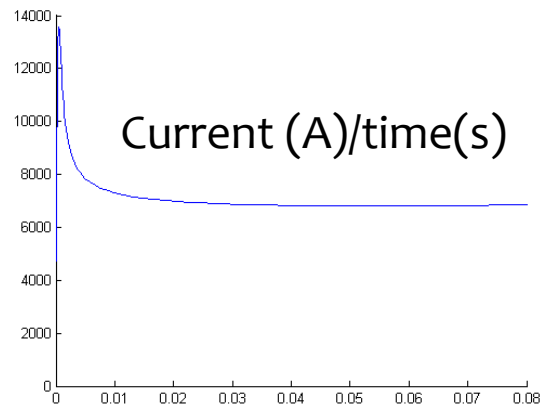
Naoyuki Higo, Nevsan Sengil, Shingo Fuchikami,
Taiki Masutani, Vidmantas Tomkus

Student Project

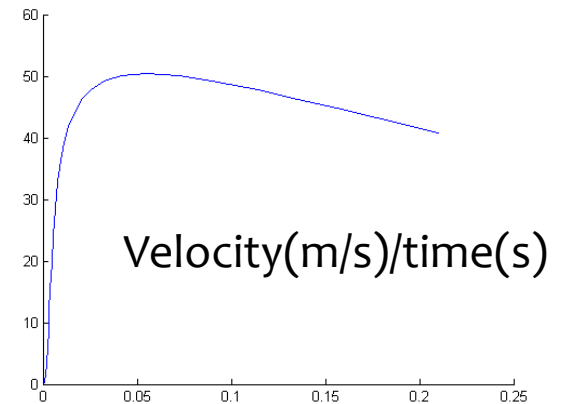
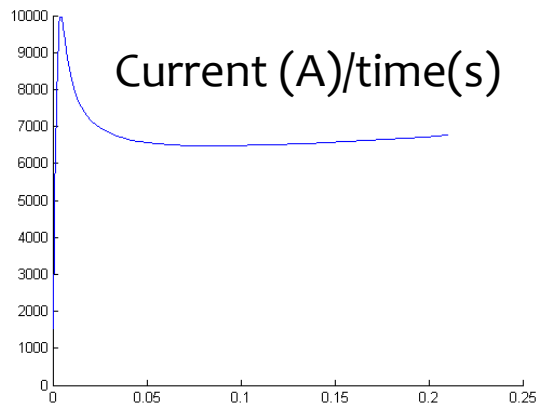
- * Case 1:
- * Altitude=100 m
- * $L=5$ m
- * $V_i=44$ m/s
- * $a=20$ G



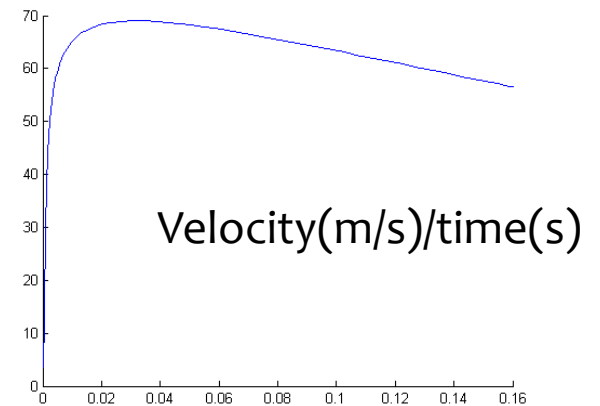
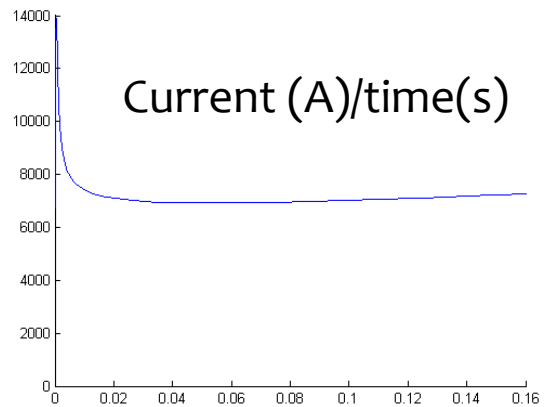
- * Case 2:
- * Altitude=200 m
- * $L=5$ m
- * $V_i=63$ m/s
- * $a=40$ G



- * Case 3:
- * Altitude=100 m
- * L=10 m
- * $V_i=44$ m/s
- * $a=10$ G



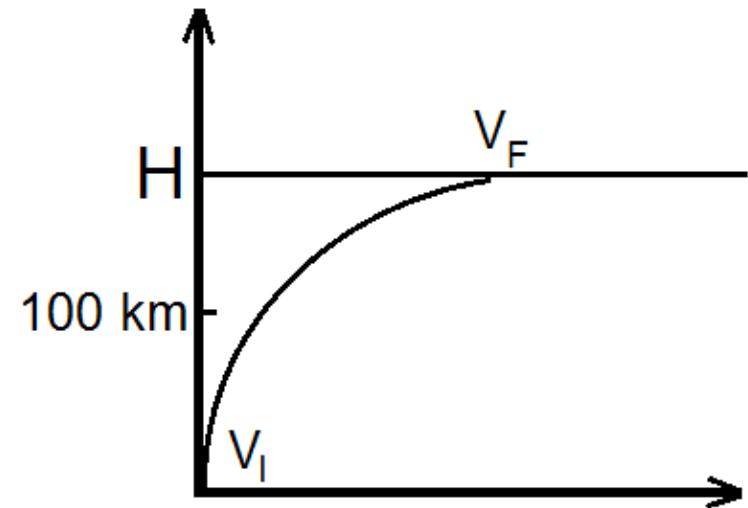
- * Case 4:
- * Altitude=200 m
- * L=10 m
- * $V_i=63$ m/s
- * $a=20$ G



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
- * Length 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.

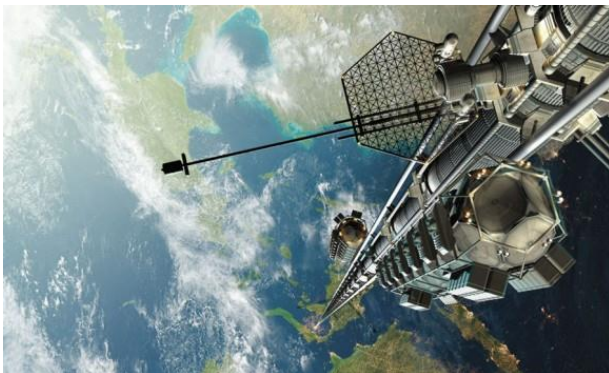


ROCKETS

- ❖ 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/>

The Laser Launch Concept

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

Vehicle

- Small
- Simple
- Cheap
- Inert

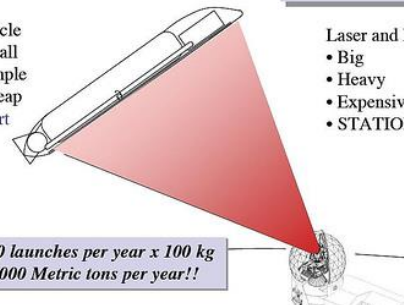
Leave The Hard Parts On The Ground!

Laser and Beam Projector

- Big
- Heavy
- Expensive
- STATIONARY

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

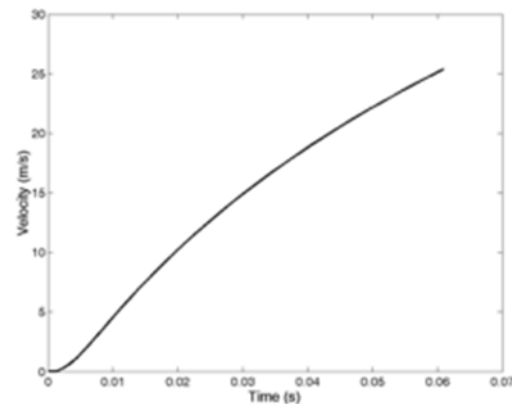
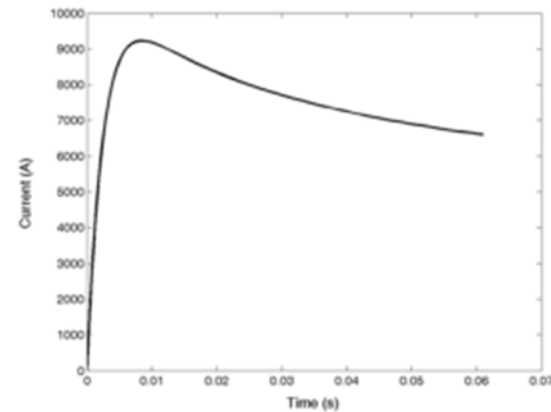
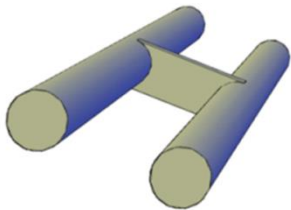
- * We want to propose a discussion topic about how to design an EML to be capable of launching pico satellites ($m < 1$ kg) into LEO.
- * Or maybe a small scale EML can be built just to send Cansats to an altitude of a couple of 100 meters for university students.



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

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