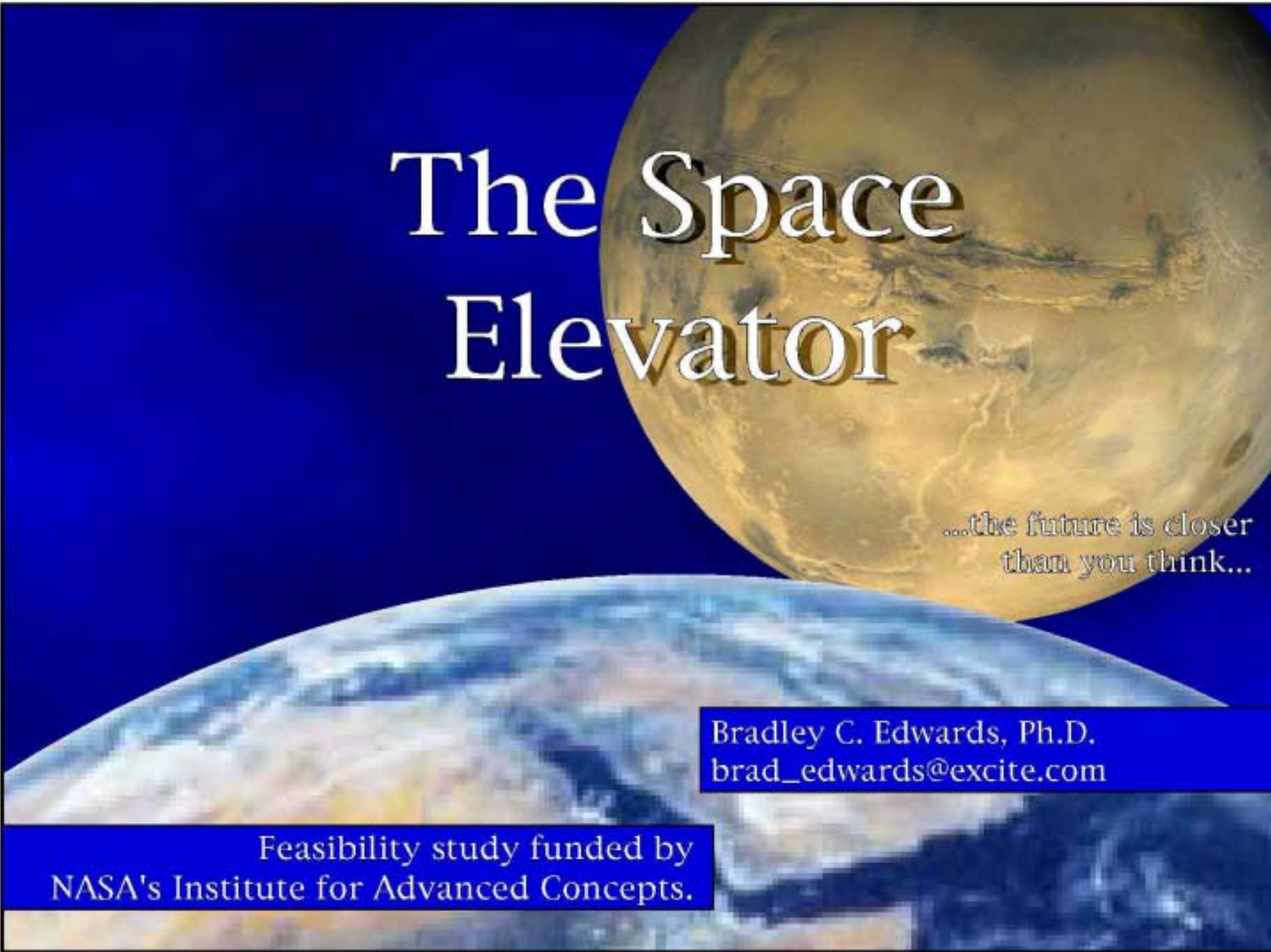
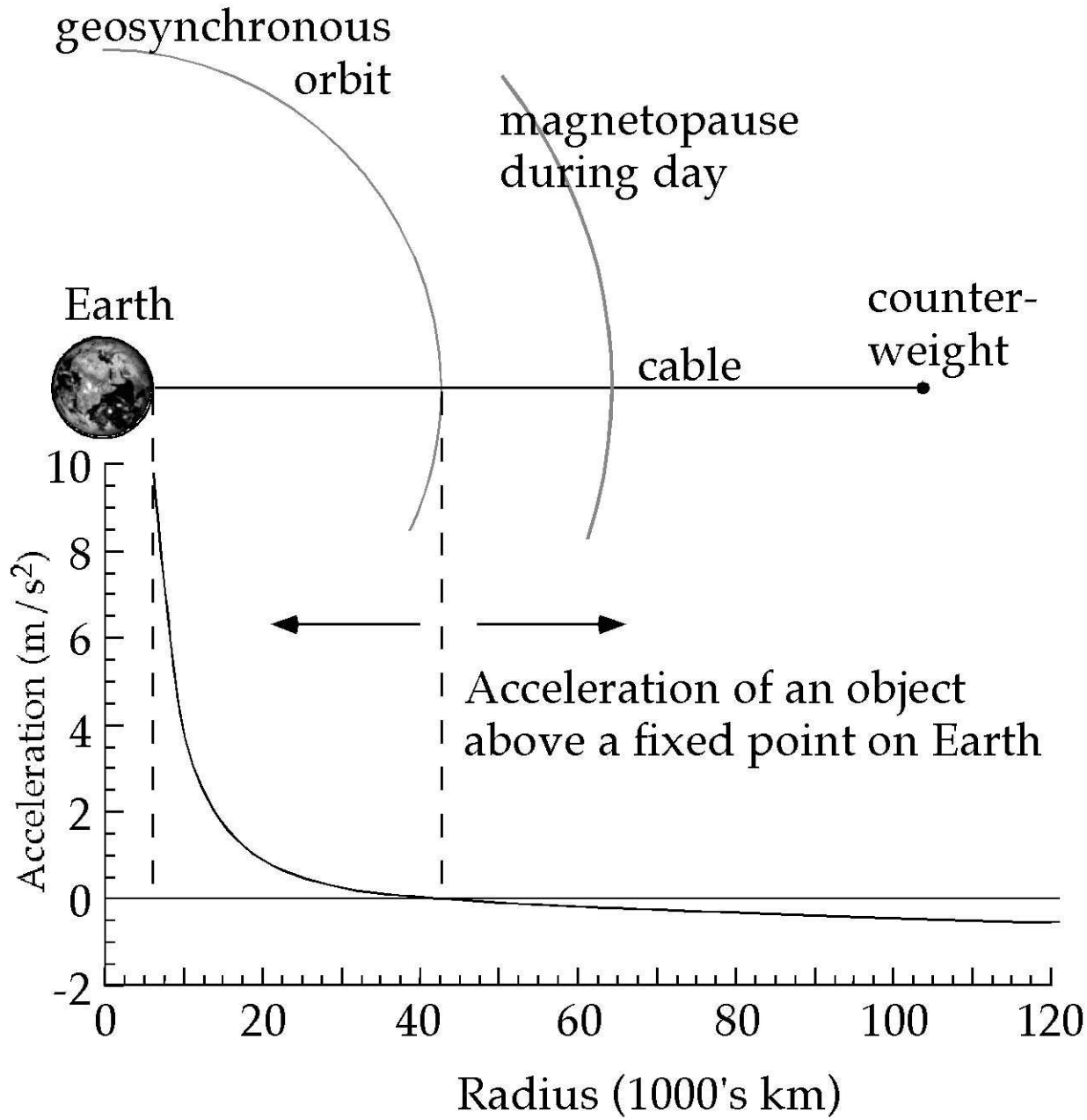

The Space Elevator
...the future is closer than you think...
Bradley C. Edwards, Ph.D.
brad_edwards@excite.com
Feasibility study funded by NASA's Institute for Advanced Concepts.

The Space Elevator



THE SPACE ELEVATOR

Aspects of a Space Elevator:

Design and Deployment

- Cable Design and Production ✓
- Spacecraft and Climbers
- Power Beaming
- Deployment ✓
- Anchor
- Destinations ✓
- Safety Factor
- Design Options

Operational Challenges

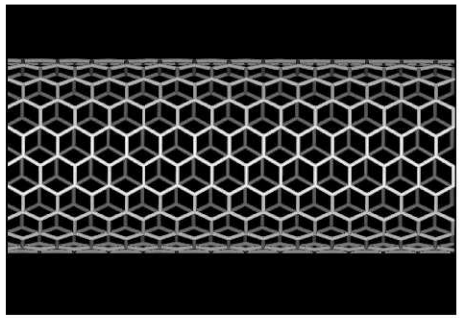
- Lightning
- Meteors
- Low-Earth-Orbit Objects
- Wind
- Atomic Oxygen
- Electromagnetic Fields
- Radiation
- Induced Oscillations ✓
- Environmental Impact

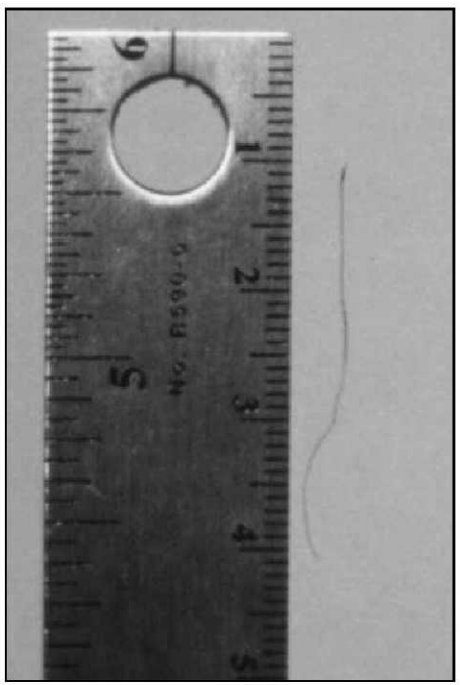
Programmatic

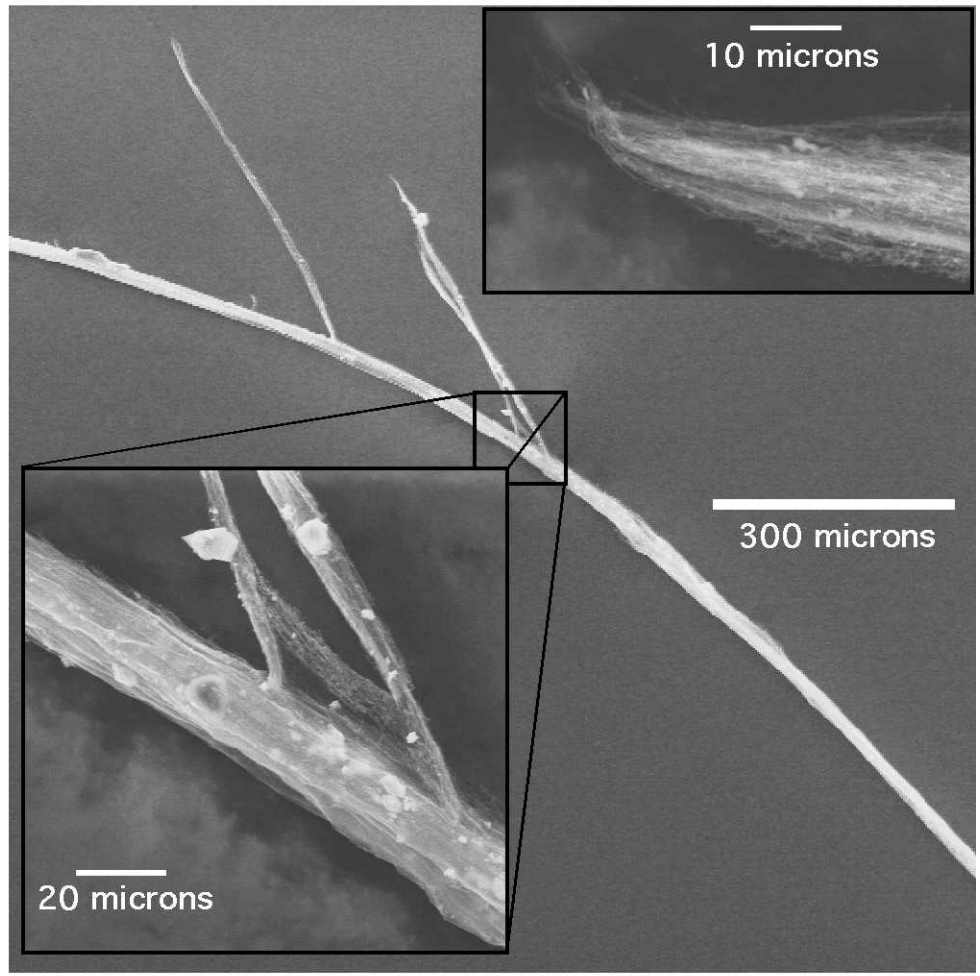
- Future Work
- Budget Estimates
- Schedule

THE SPACE ELEVATOR

Carbon Nanotubes

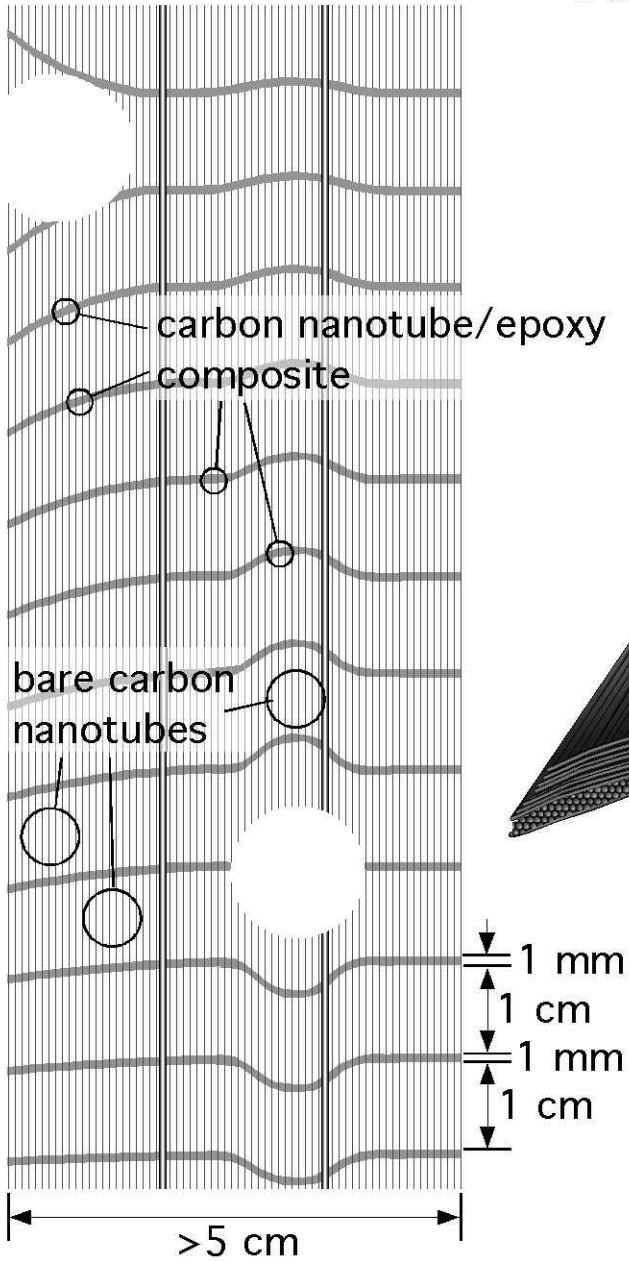


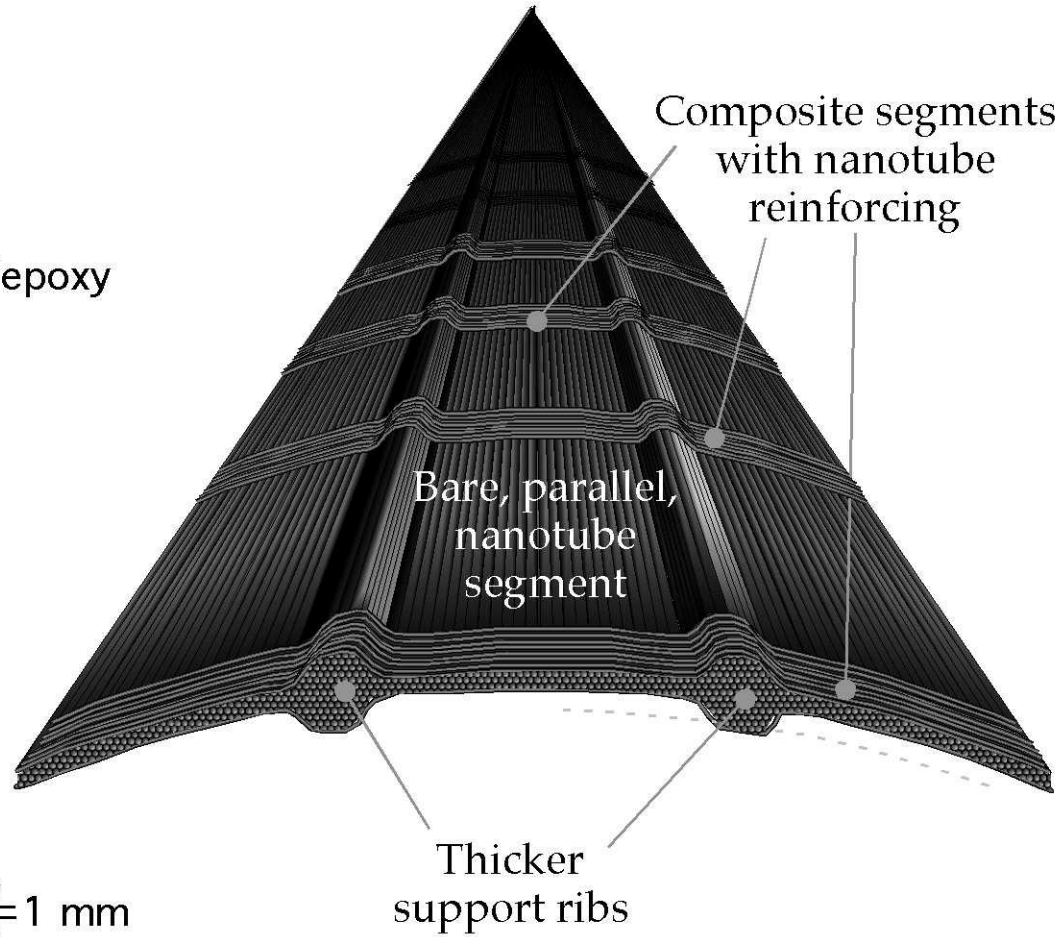




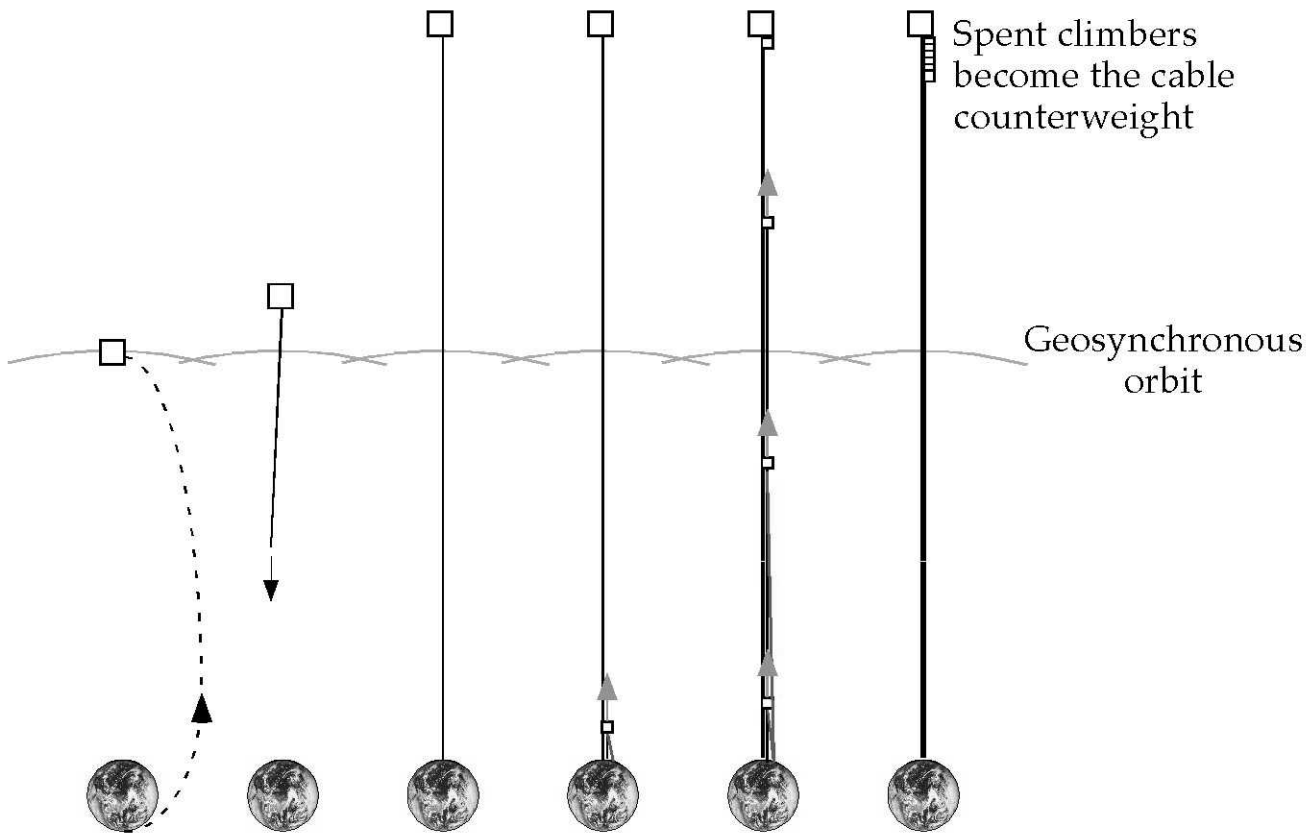
The Space Elevator

The Cable





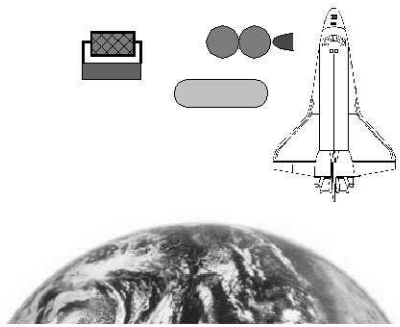
Space Elevator Deployment Scenario



THE SPACE ELEVATOR

Deployment Scenario

A



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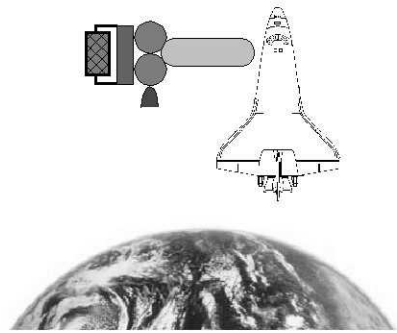

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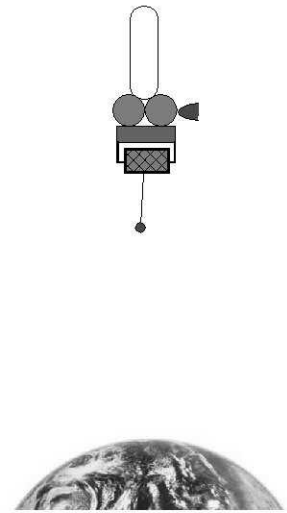

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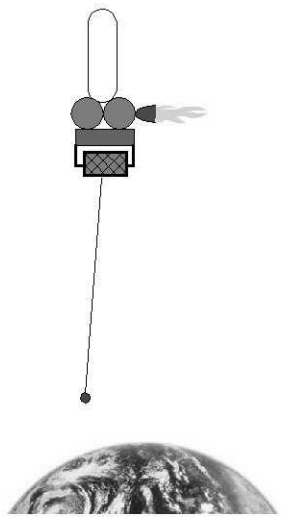

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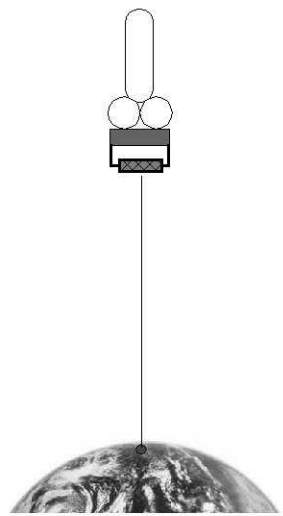

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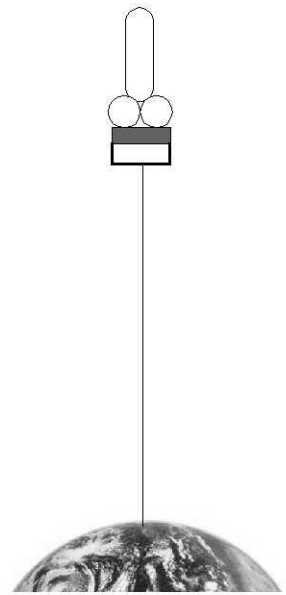
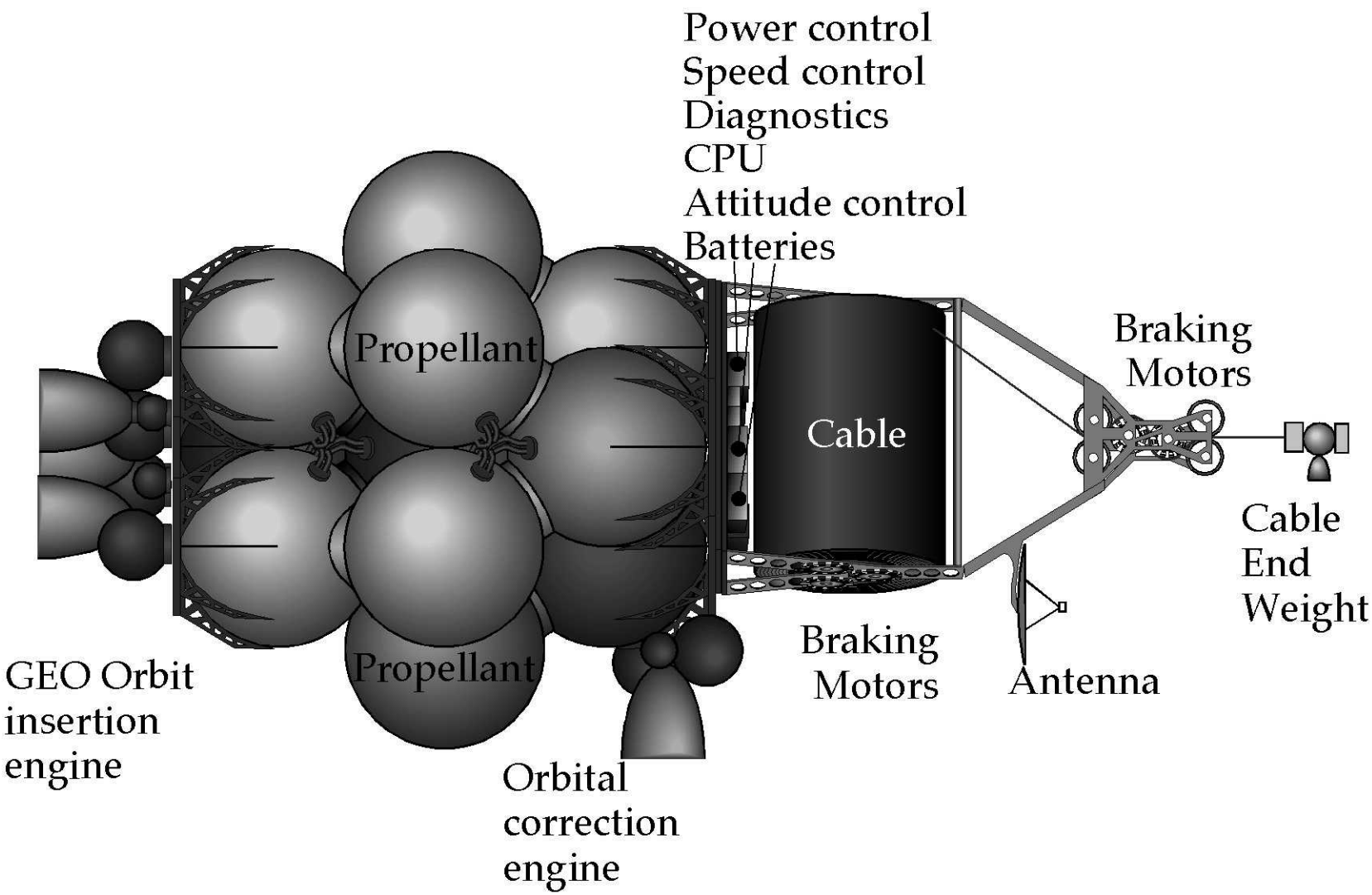
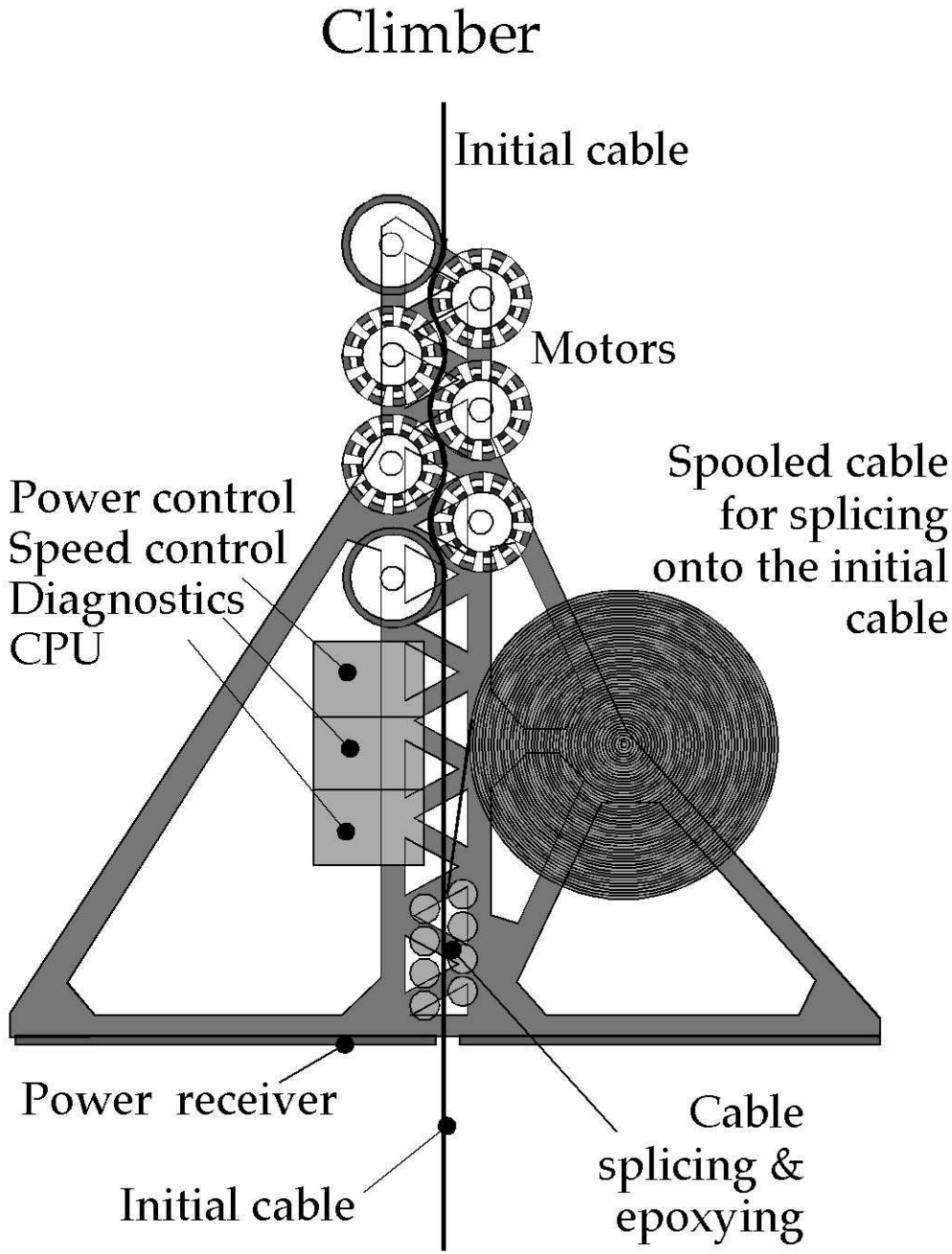


Deployment Spacecraft

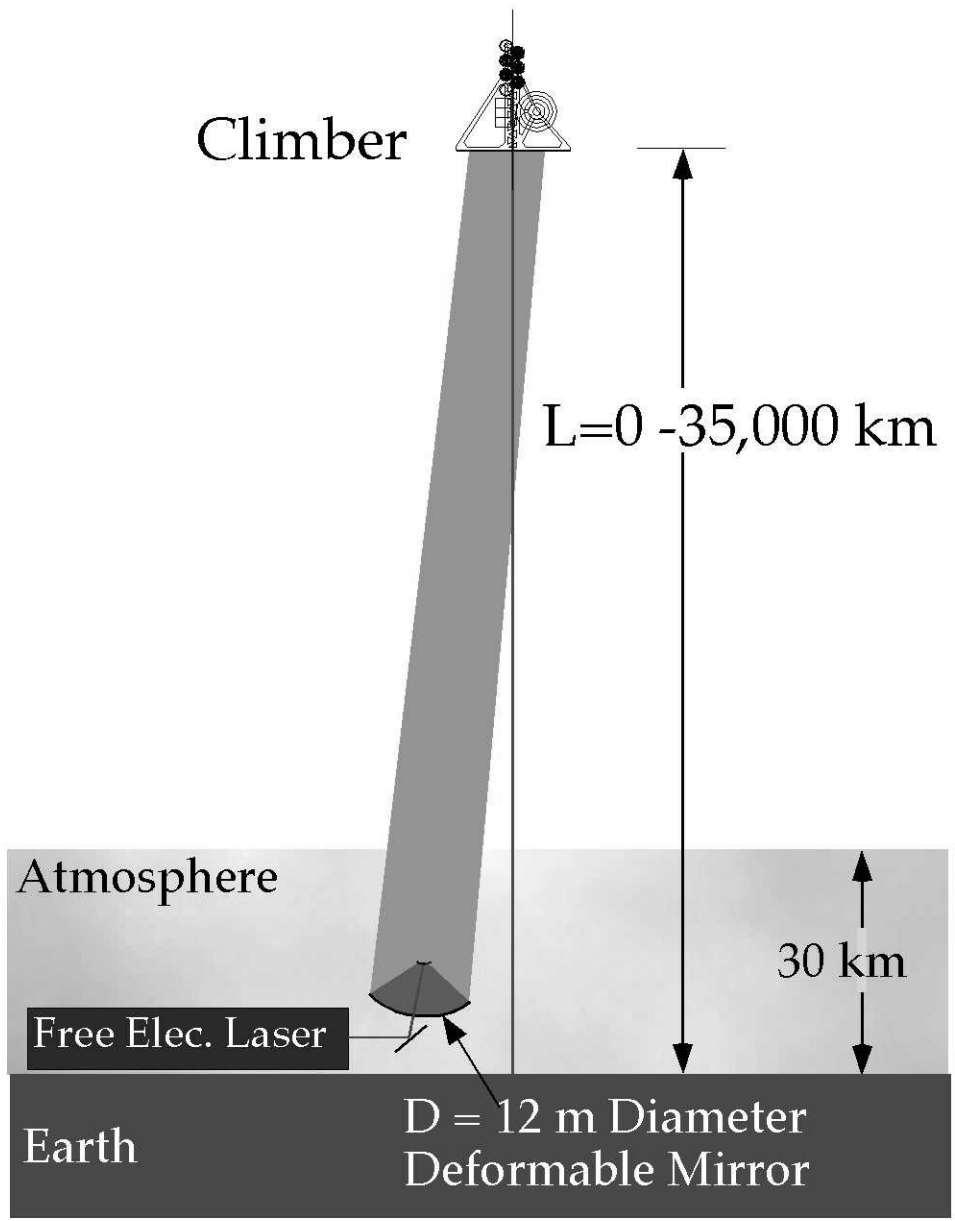


The Space Elevator



THE SPACE ELEVATOR

Power Beaming



Cable Characteristics

Length:	96,000 km*
Cable Material:	Carbon nanotube/epoxy
Taper Ratio:	2.3
Safety Factor:	2
Lift Capacity:	20,000 kg / 97 hours 12,000 payload
Dimensions:	microns × meter (2 mm^2)
Cable Mass:	572,000 kg
Counterweight:	621,000 kg
Destinations:	LEO - Venus/Jupiter

* NOTE: Currently there are 310,000 kms of trans-oceanic cables, one is 28,000 km and 2.5 cm thick (500 mm^2)

THE SPACE ELEVATOR

Deployment Characteristics

Launch Vehicle:	7 - Shuttles
Total Propellant:	123,000 kg
Dry mass:	48,000 kg
Initial Cable:	19,800 kg
Initial Lift Capacity:	619 kg
Time Between Climbers:	97 hours

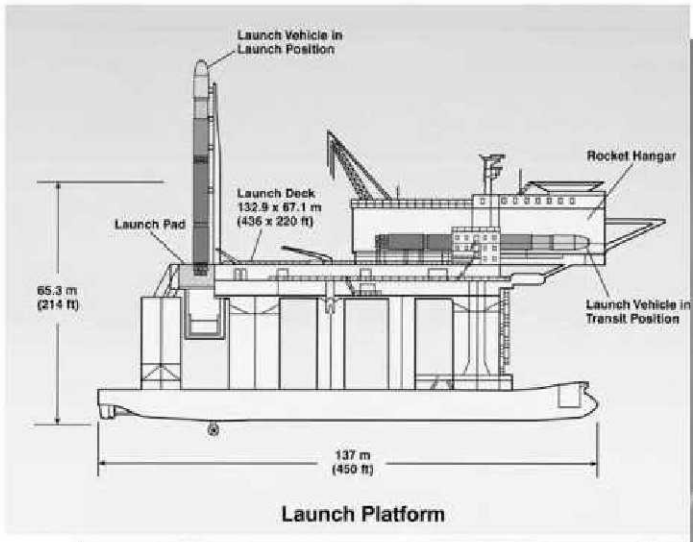
Climber Characteristics

Cable Mass:	288 kg / 12,000
Climber Mass:	331 kg / 8000
Total Mass:	619 kg / 20,000 kg
Cable / Counterweight	0.87
Cap. Increase per Climber:	1.6%
Max. climber Velocity:	200 km/hr
Power required:	50 kW / 1.6 MW
Motor Mass:	75 kg / 2400 kg
Power Receiver Mass:	21 kg / 680 kg

To Complete 20,000 kg Capacity Cable

Num. of Climbers:	207
From Launch to Comp.:	28 months

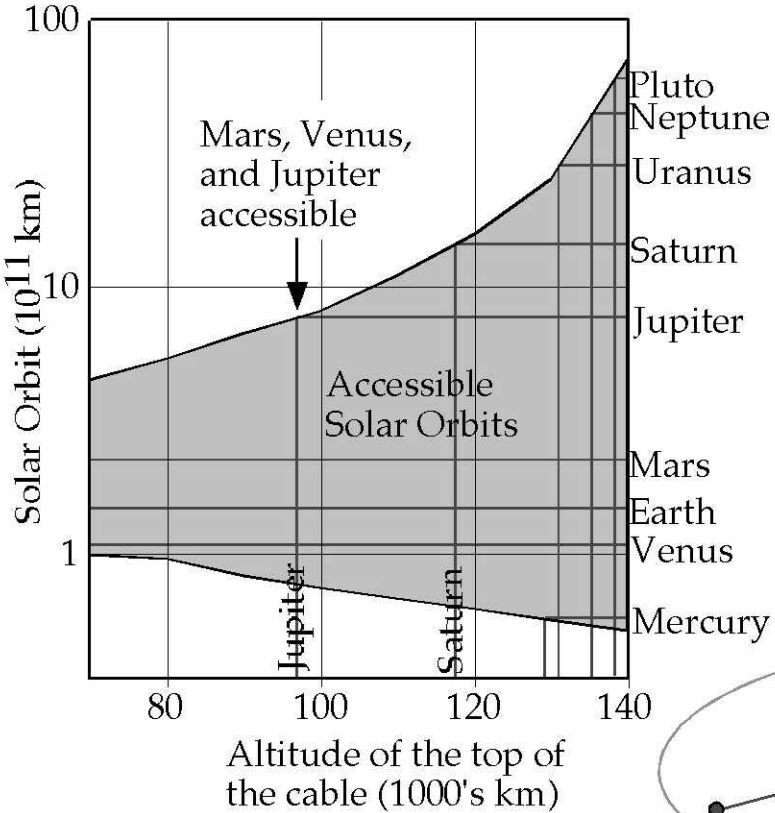
The Anchor

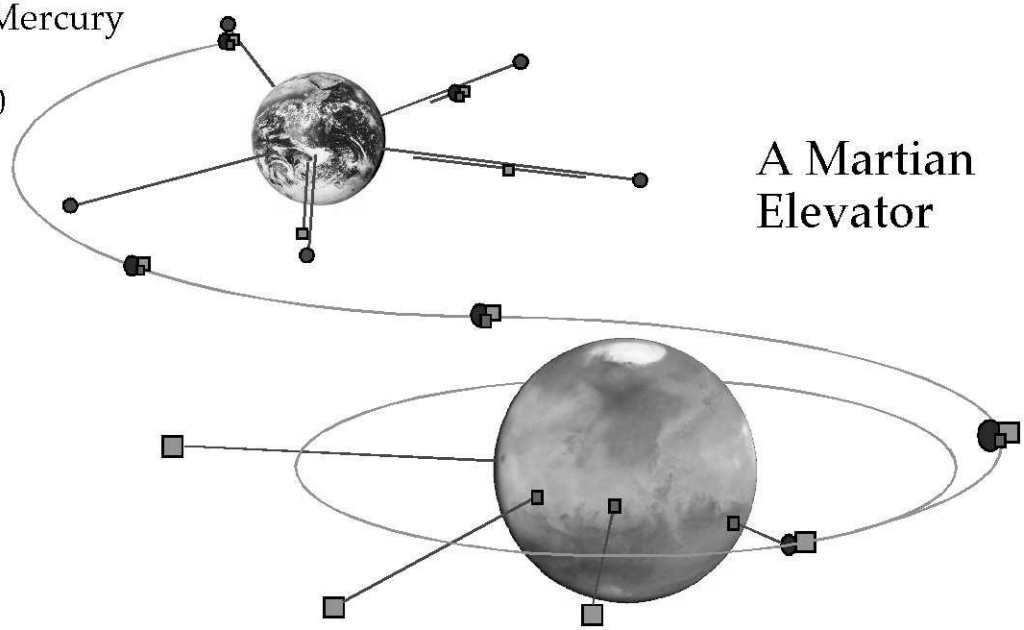


Launch Platform

The Space Elevator

Destinations





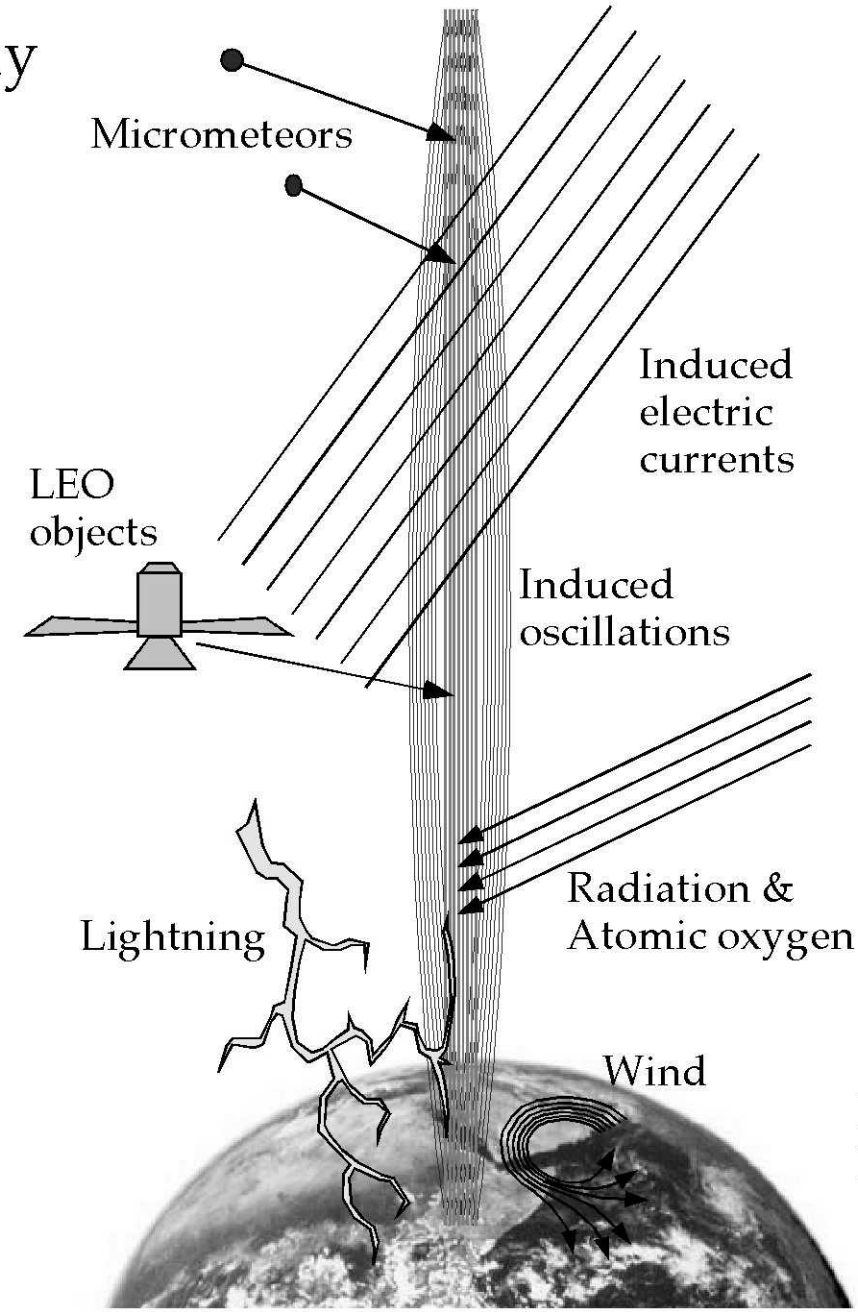
A Martian Elevator

Utilization of the Space Elevator

- A space elevator can launch satellites for any Earth orbit or destination between Venus and Jupiter every 4 days
- In 2.8 years any 20,000 kg cable can be strengthened to a 1 million kg cable
- In 170 days any cable can spawn a second equivalent cable which can be transported to a new location
- Cables can be used for commercial, research, entertainment,...

The Space Elevator

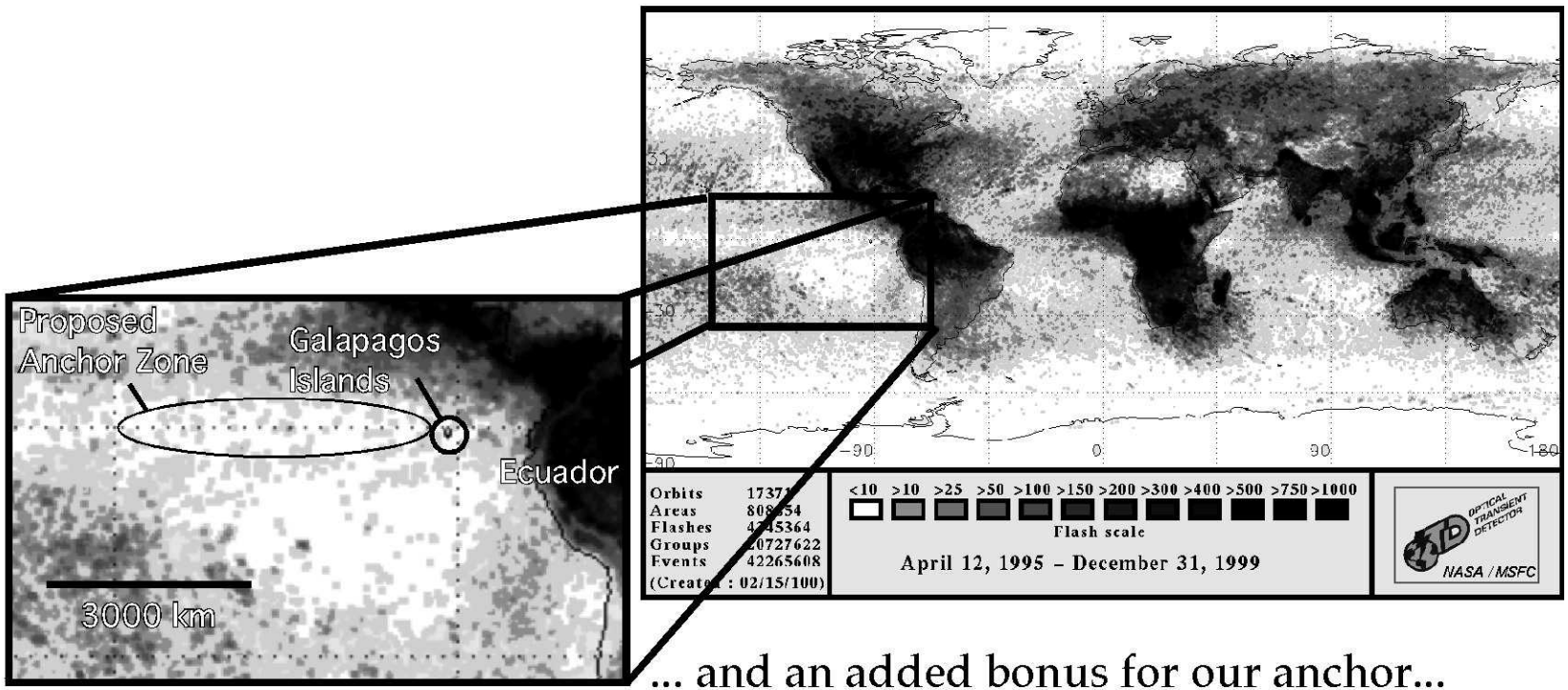
Murphy



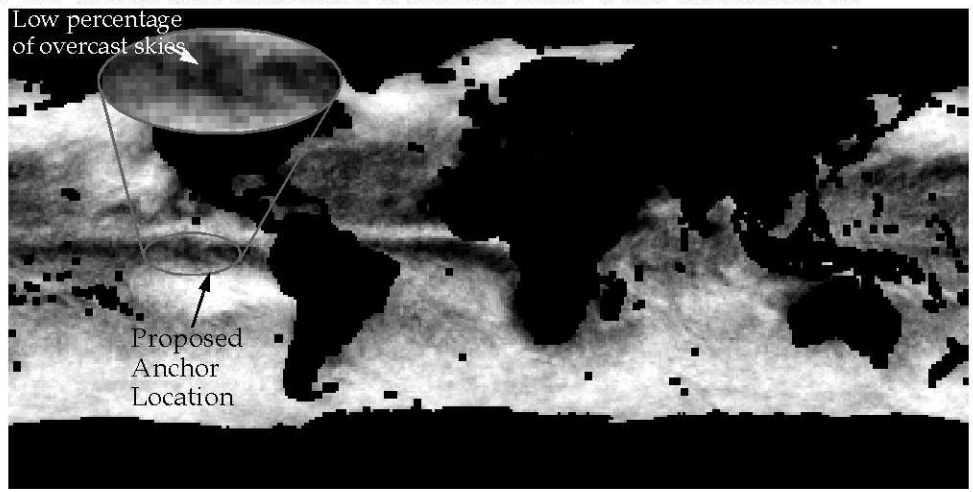
Severed cables and malfunctioning climbers

Environmental Impact - Ionosphere & Re-entry

Lightning



... and an added bonus for our anchor...

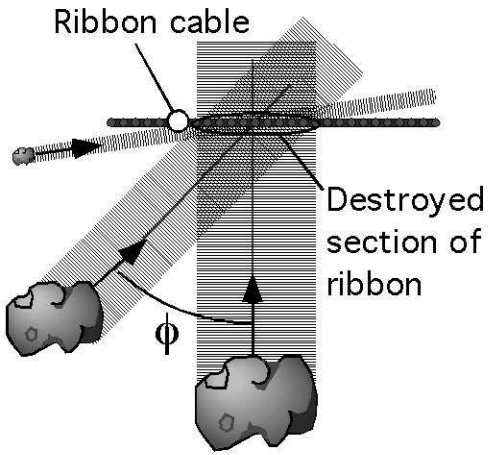


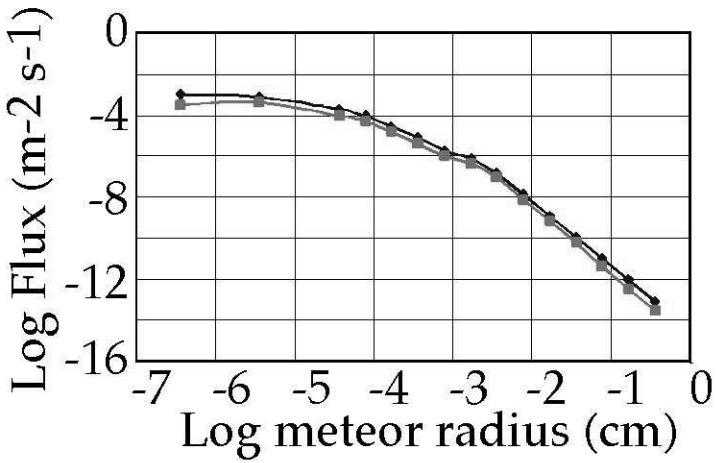
Cloudiness

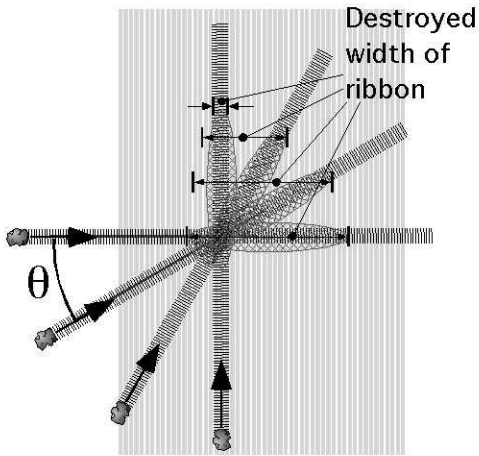
THE SPACE ELEVATOR

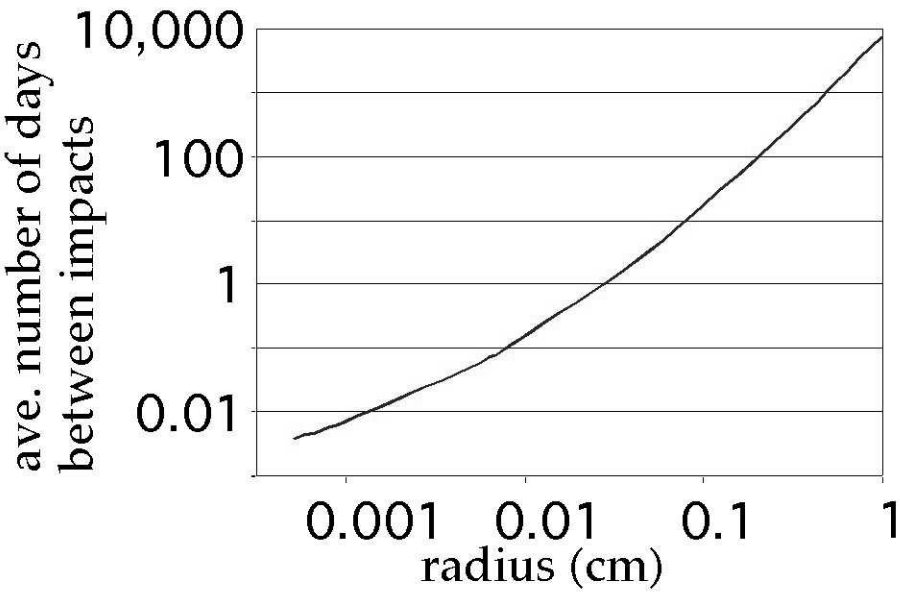
THE SPACE ELEVATOR

Meteors and Debris

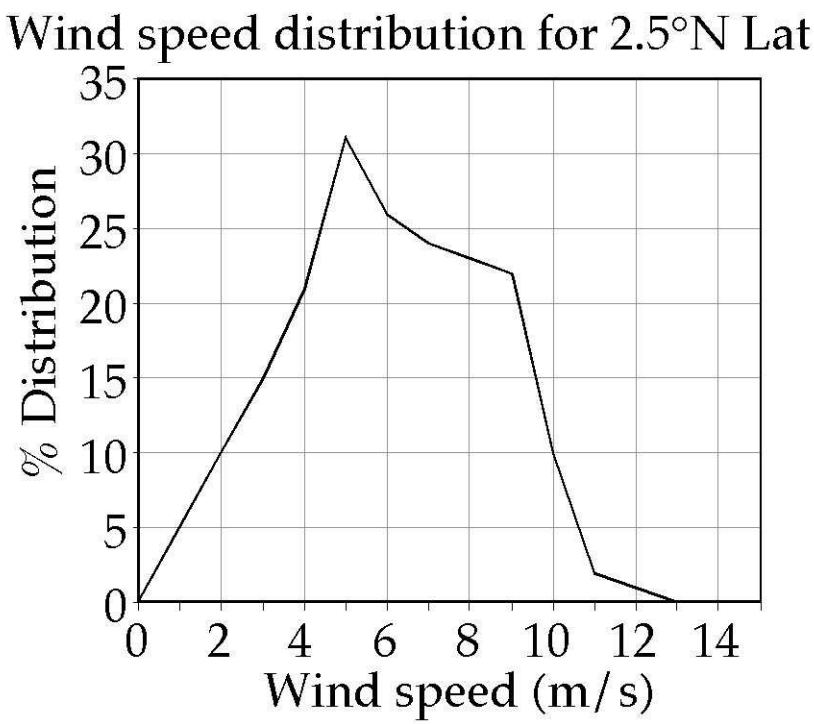


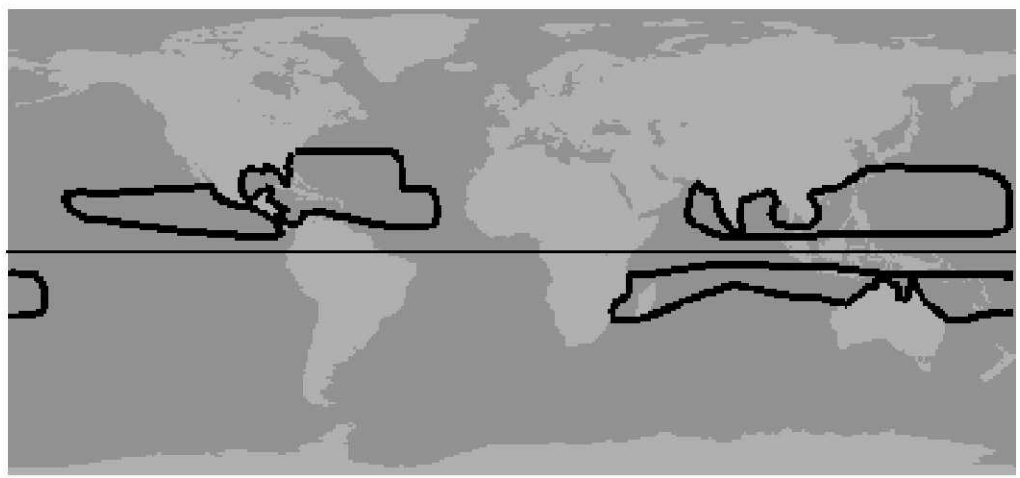






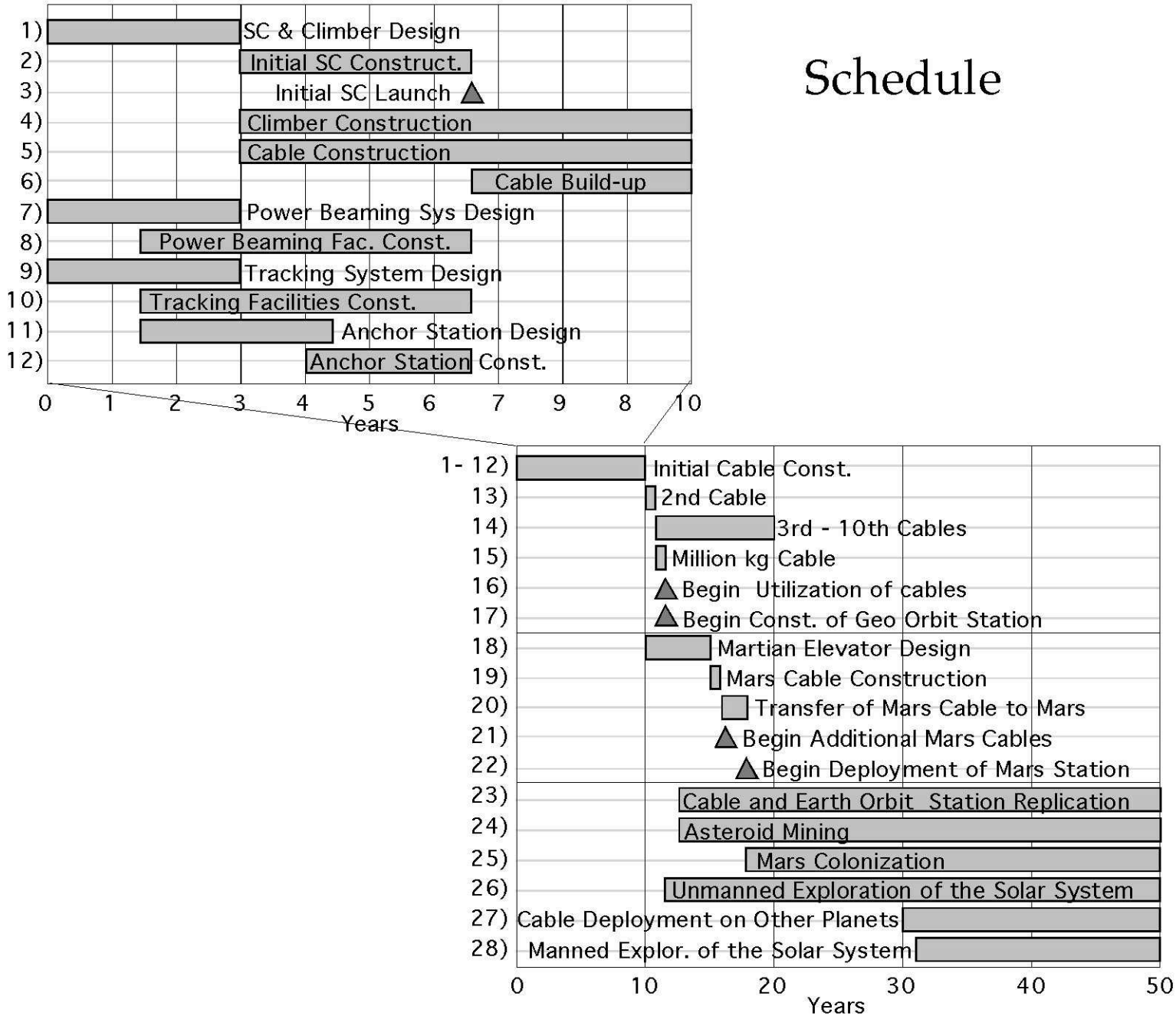
Wind Loading





The Space Elevator

Schedule



THE SPACE ELEVATOR

Budget Summary

Component	Cost Estimate
Launch costs to GEO	$3.7B
Cable production	$5B
Spacecraft	$1B
Climbers	$4.2B
Power beaming station	$2.2B
Power gen. station	$400M
Anchor station	$300M
Tracking facility	$1B
10-year operation	$1.56B
Misc. and cont.	$20B
TOTAL	~$40B

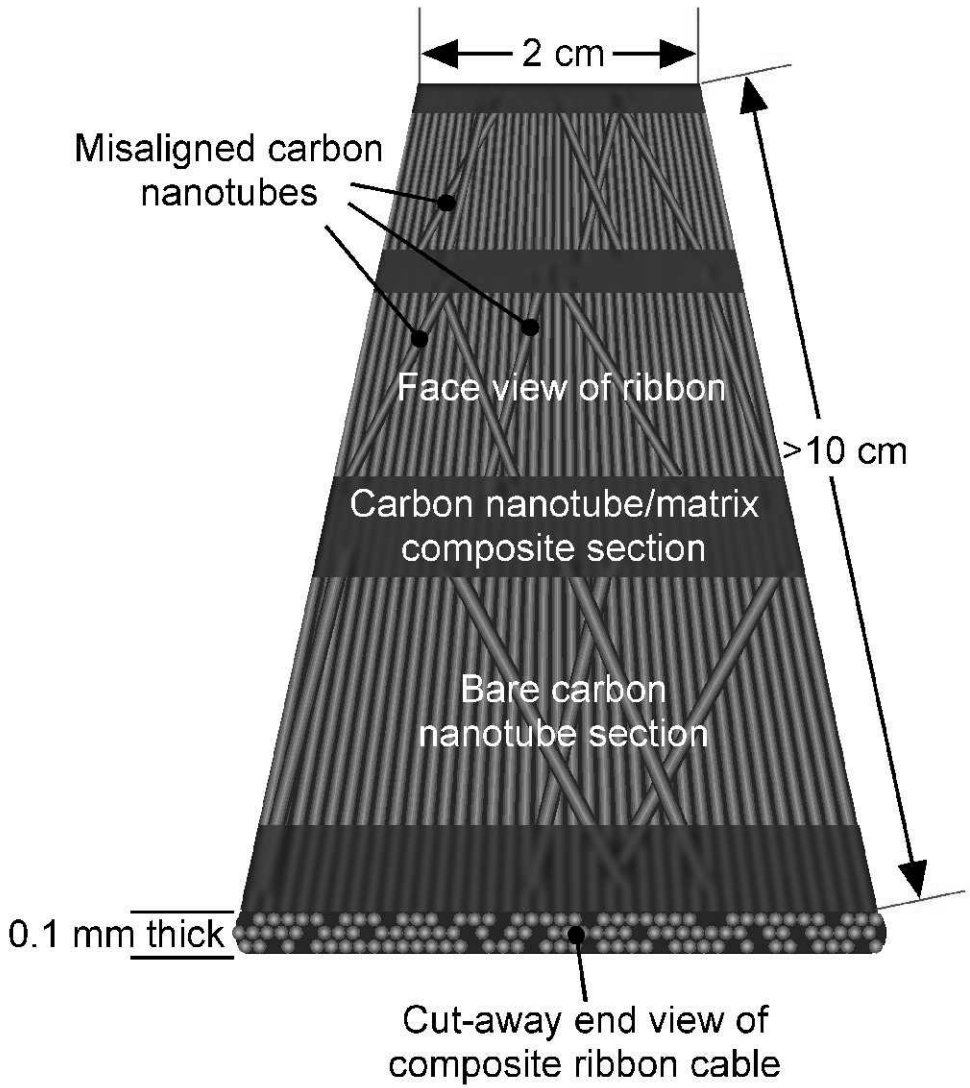
Summary

- Even though the challenges to bring the Space Elevator to reality are substantial there are no physical or economic reasons why it can't be built in our lifetime.

A compilation of this work is at www.niac.usra.edu/studies under Edwards Phase I: Final Report

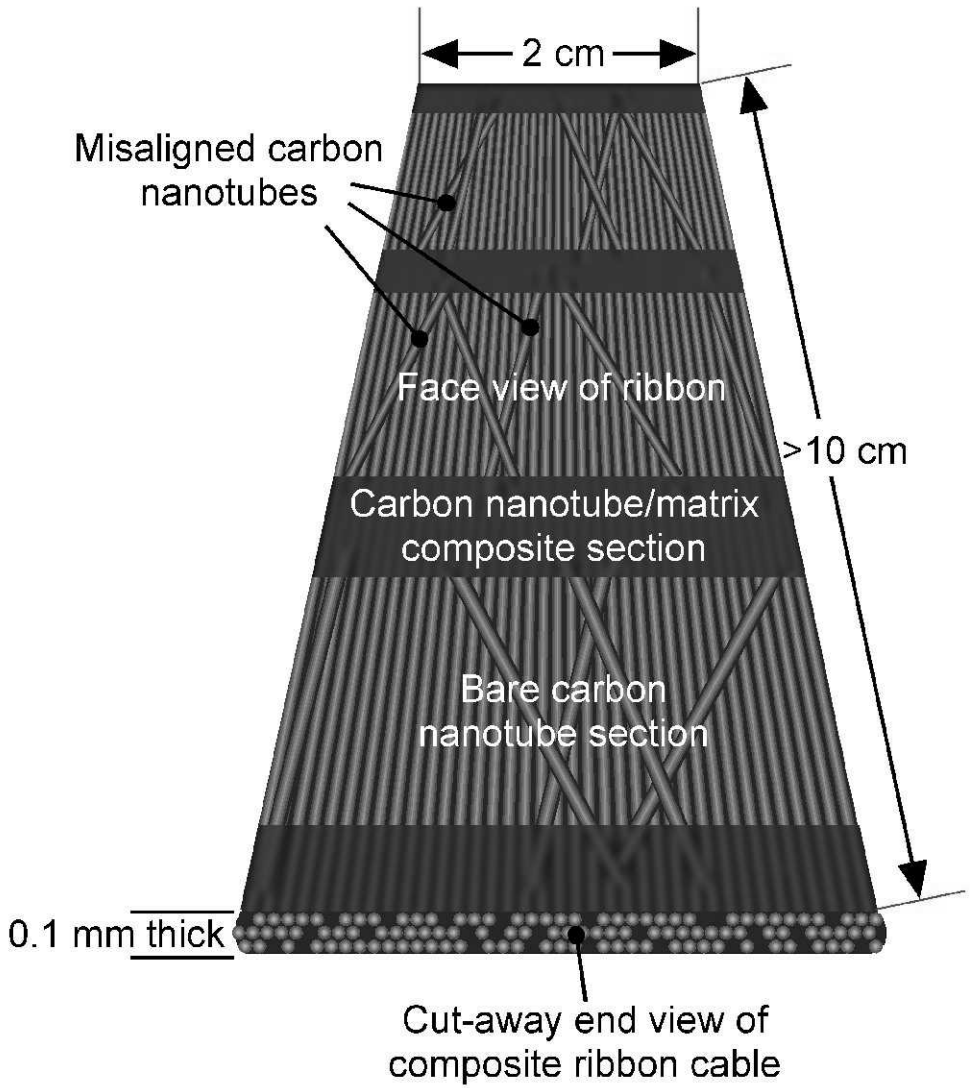
THE SPACE ELEVATOR

Cable Segments



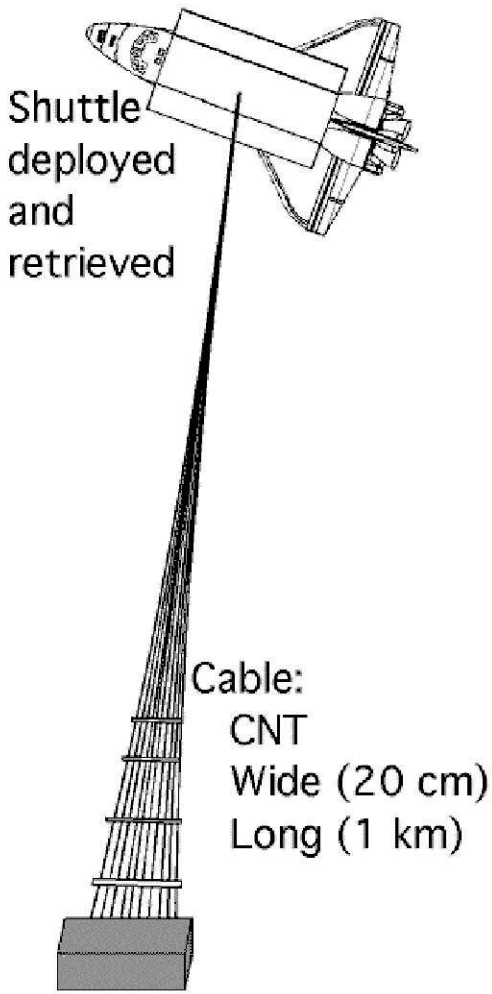
THE SPACE ELEVATOR

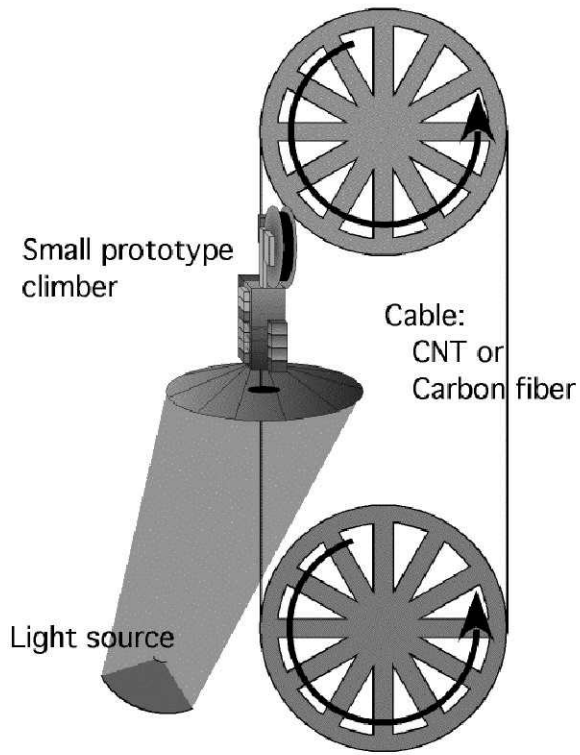
Cable Segments

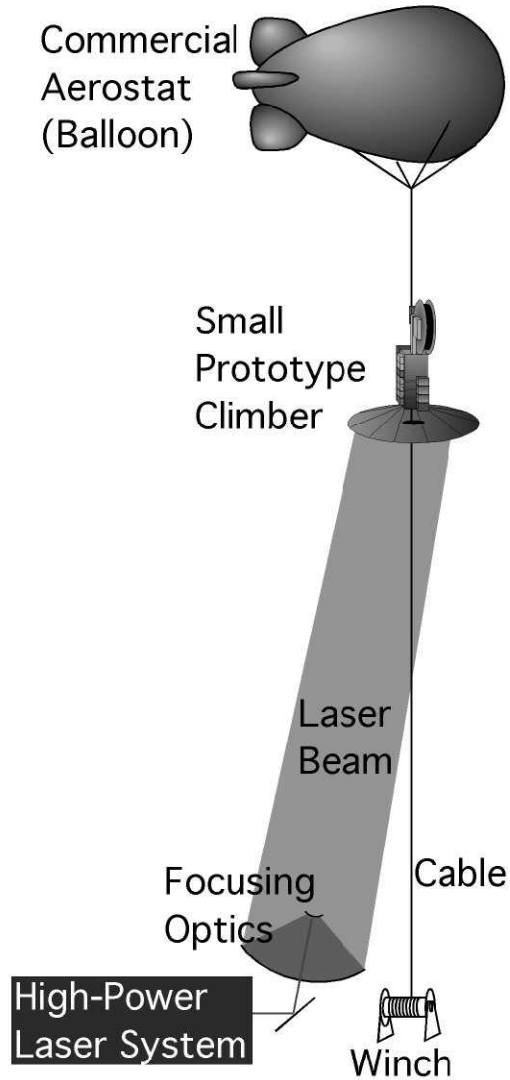


THE SPACE ELEVATOR

Feasibility Tests





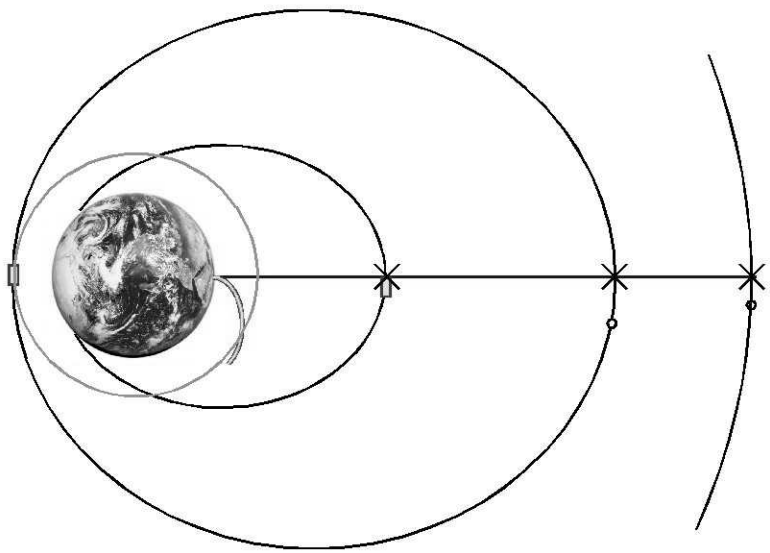


Elevators on Other Planets

- Depends on planet mass, rotation rate, uses, and other nearby bodies
- Concerns include radiation, other orbital objects, atmospheric affects, synchronous objects, etc.

Ideal candidates:Mars and small rotating bodies (asteroids, small moons in the Jovian and Saturian systems)

Launch Altitudes



THE SPACE ELEVATOR