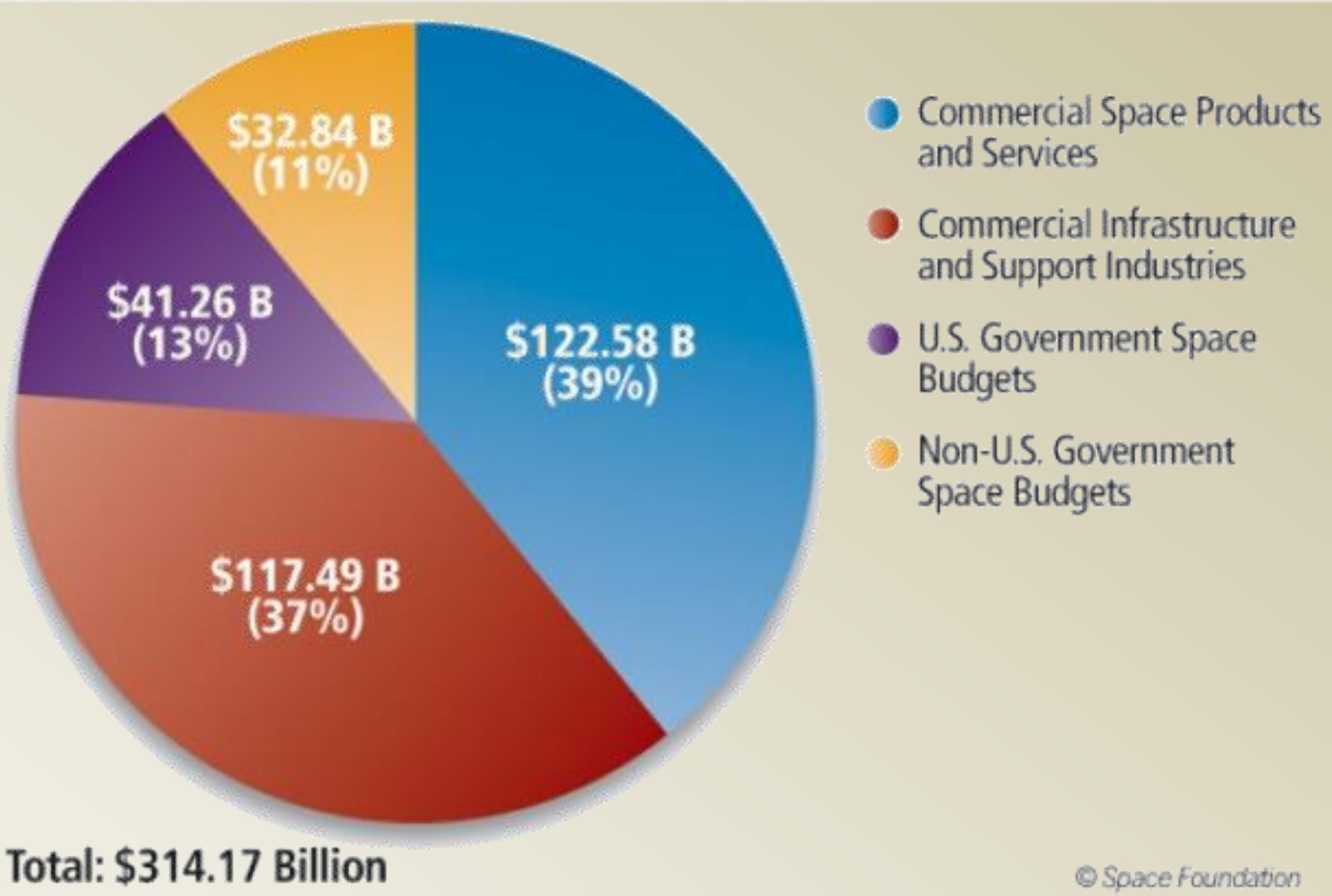
Ad Astra Rocket Company ™

http://www.adastrarocket.com/aarc/

International Presence

The Space Economy

Global Space Activity 2013

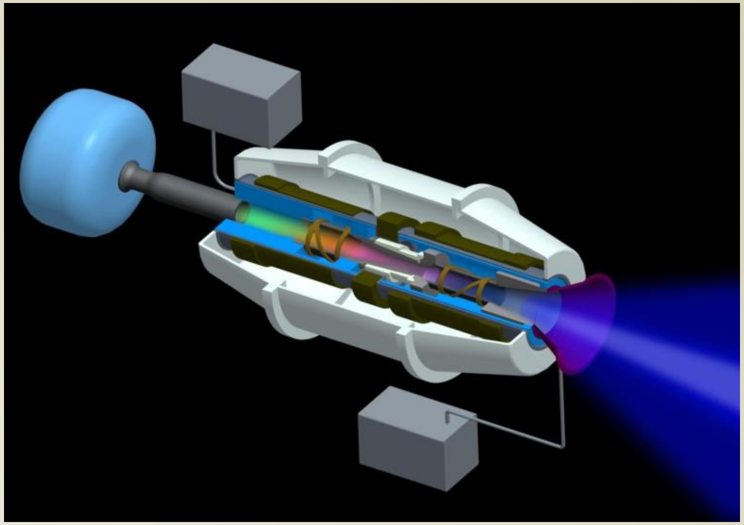


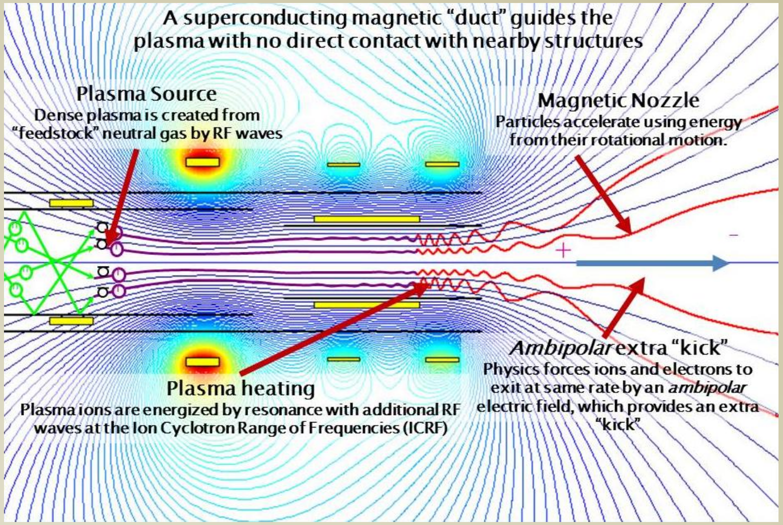
In-Space Electric Propulsion (EP)

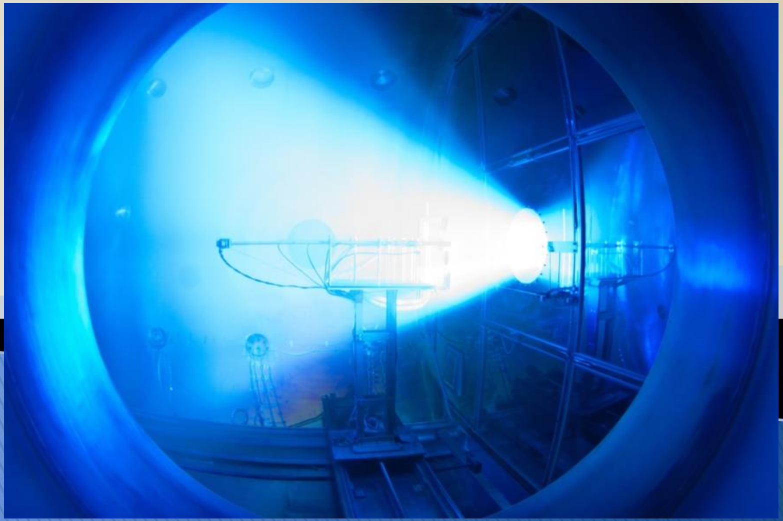
Solar Electric Propulsion

- Meets growing need
- High Priority Technology
- Solar power technology has matured
- Chemical propulsion is not economical

VASIMR® is an electric plasma rocket

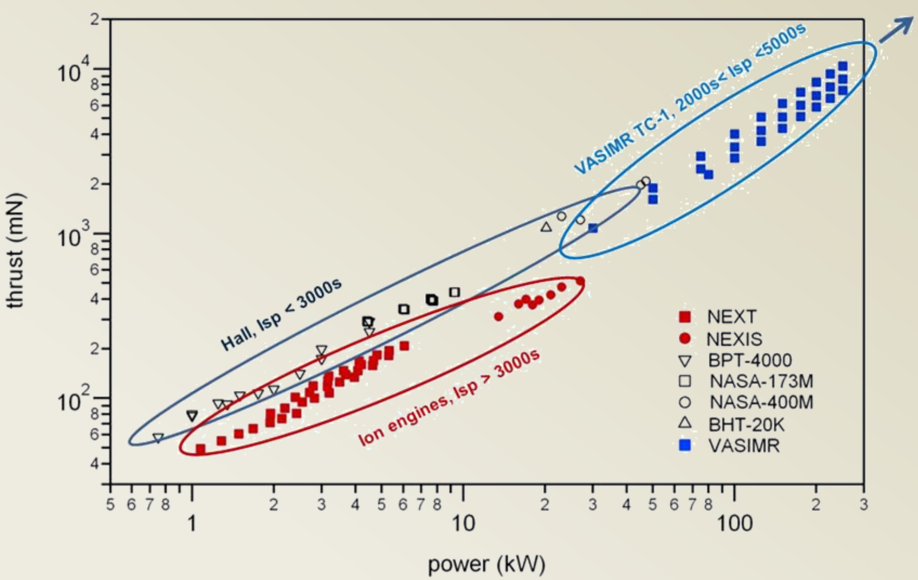


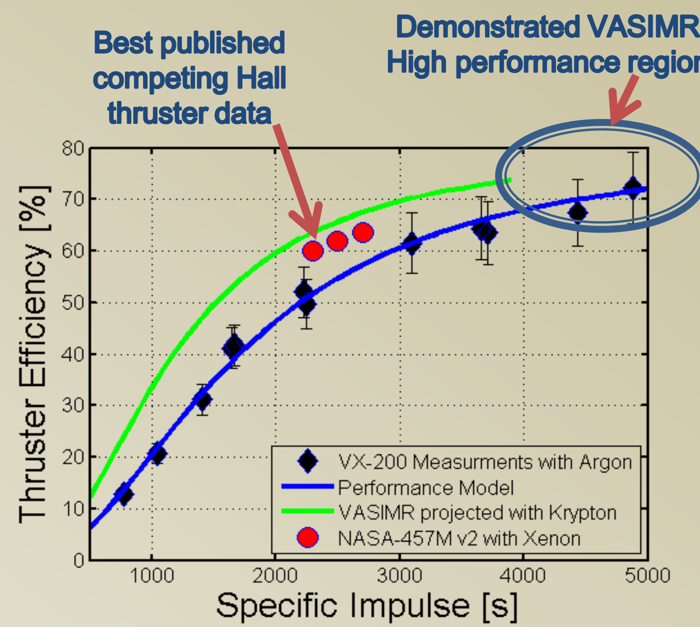




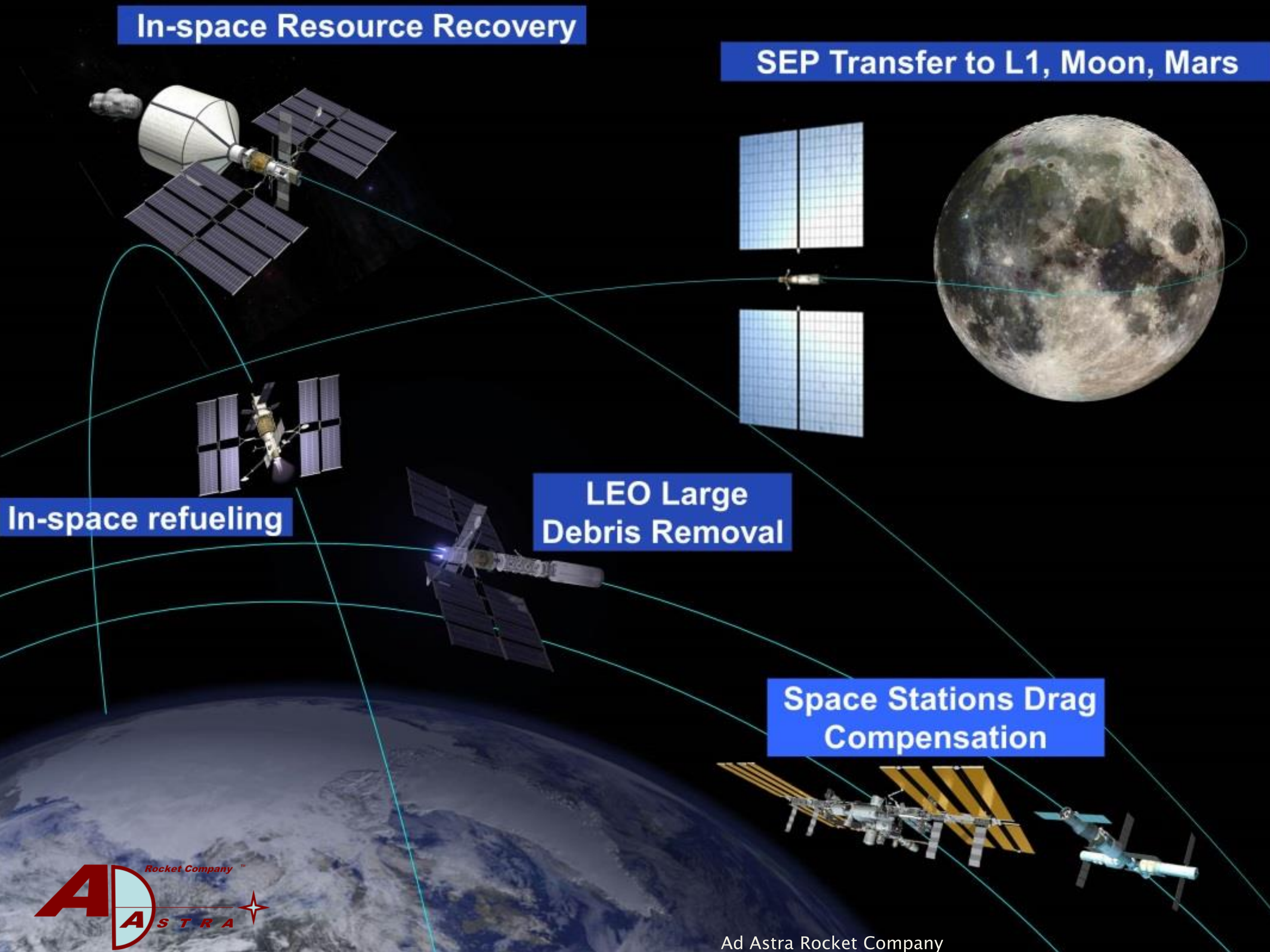
VASIMR® Performance

VASIMR® occupies a high-power niche as compared with other EP systems





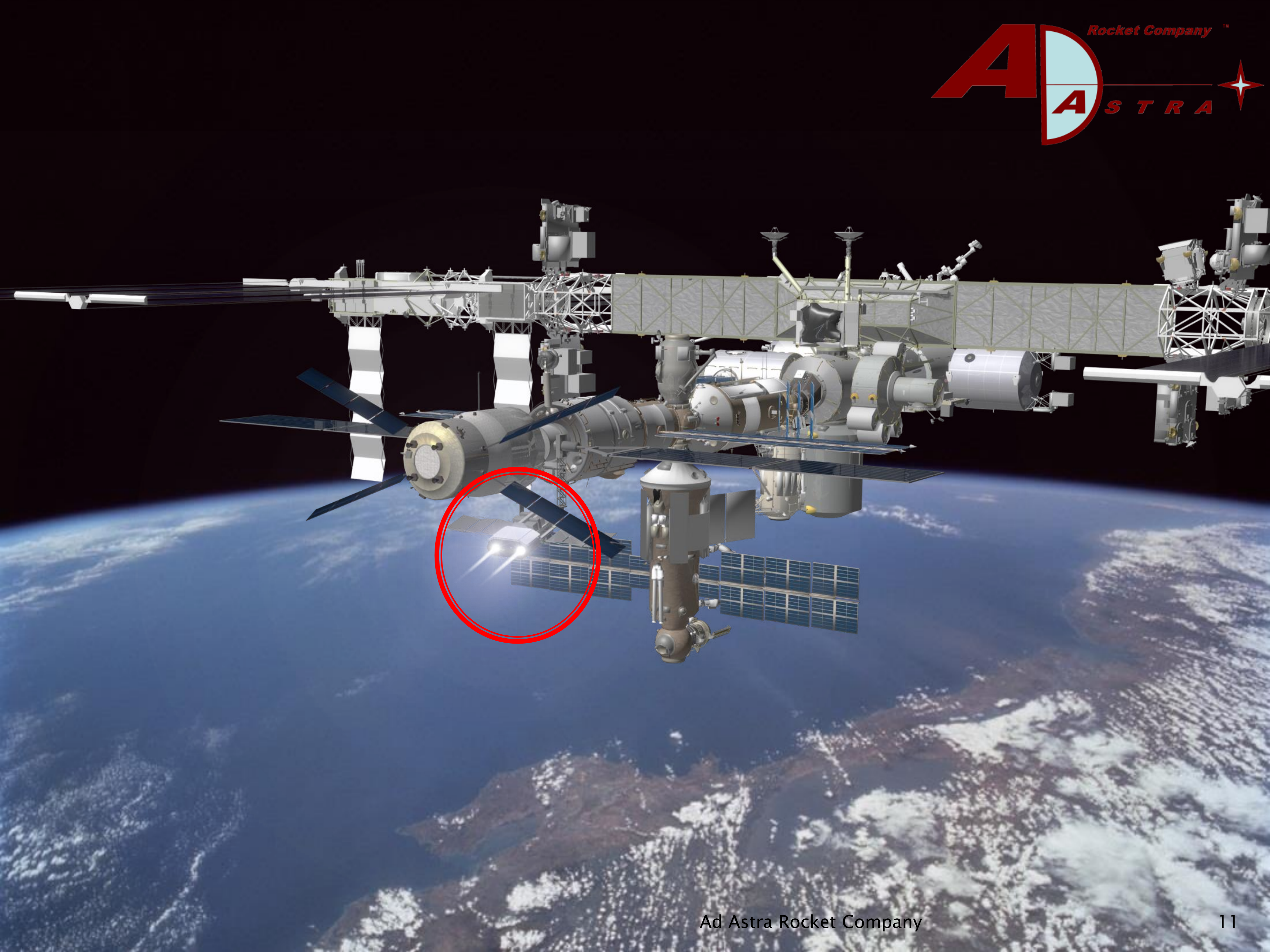
- High Power Density
- Scalable
- Measured performance
- Abundant, low cost propellants
- Electrodeless


In-space Resource Recovery
SEP Transfer to L1, Moon, Mars
In-space refueling
LEO Large
Debris Removal
Space Stations Drag
Compensation
Rocket Company
Ad Astra
Ad Astra Rocket Company

Space Station Re-boost

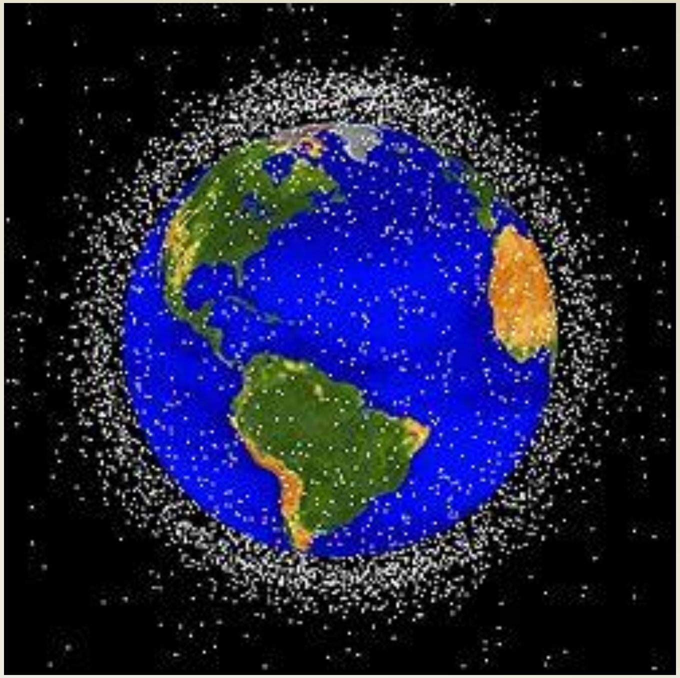
Growing Market: International Space station + Bigelow +Tiangong 1+ Excalibur

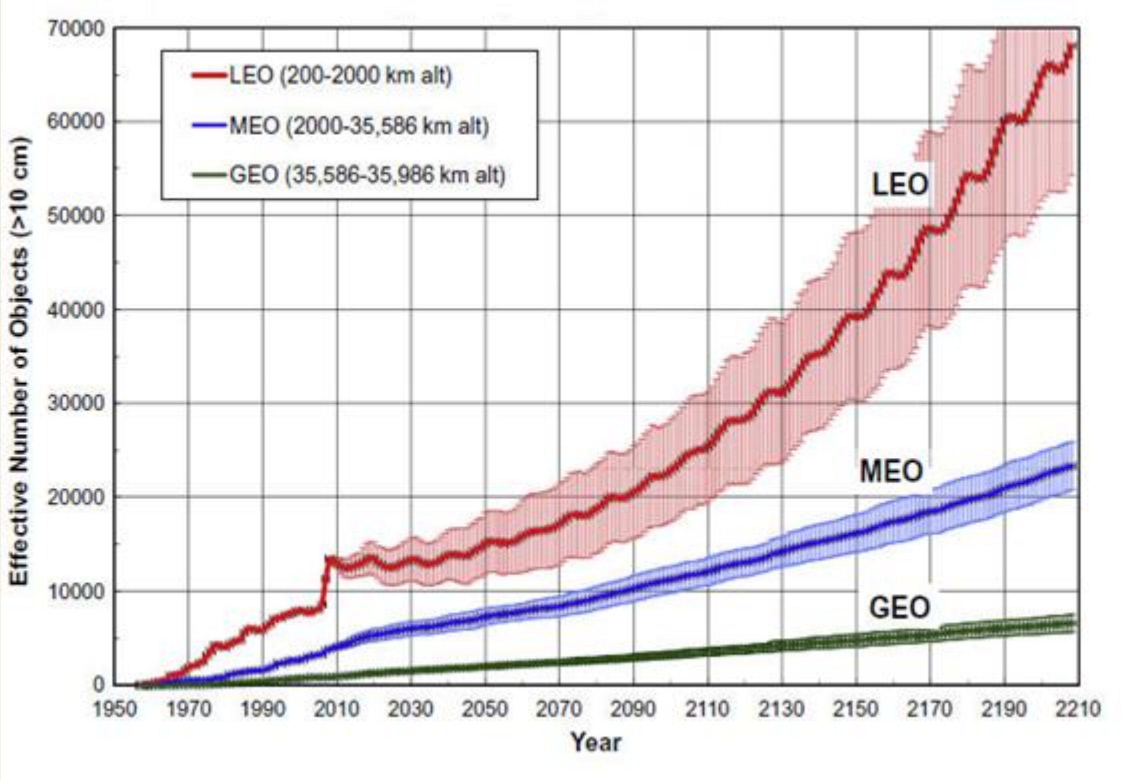
Re-boost Method	Fuel Delivery Cost per year
Chemical	Approximately $210M
VASIMR®	Approximately $20M



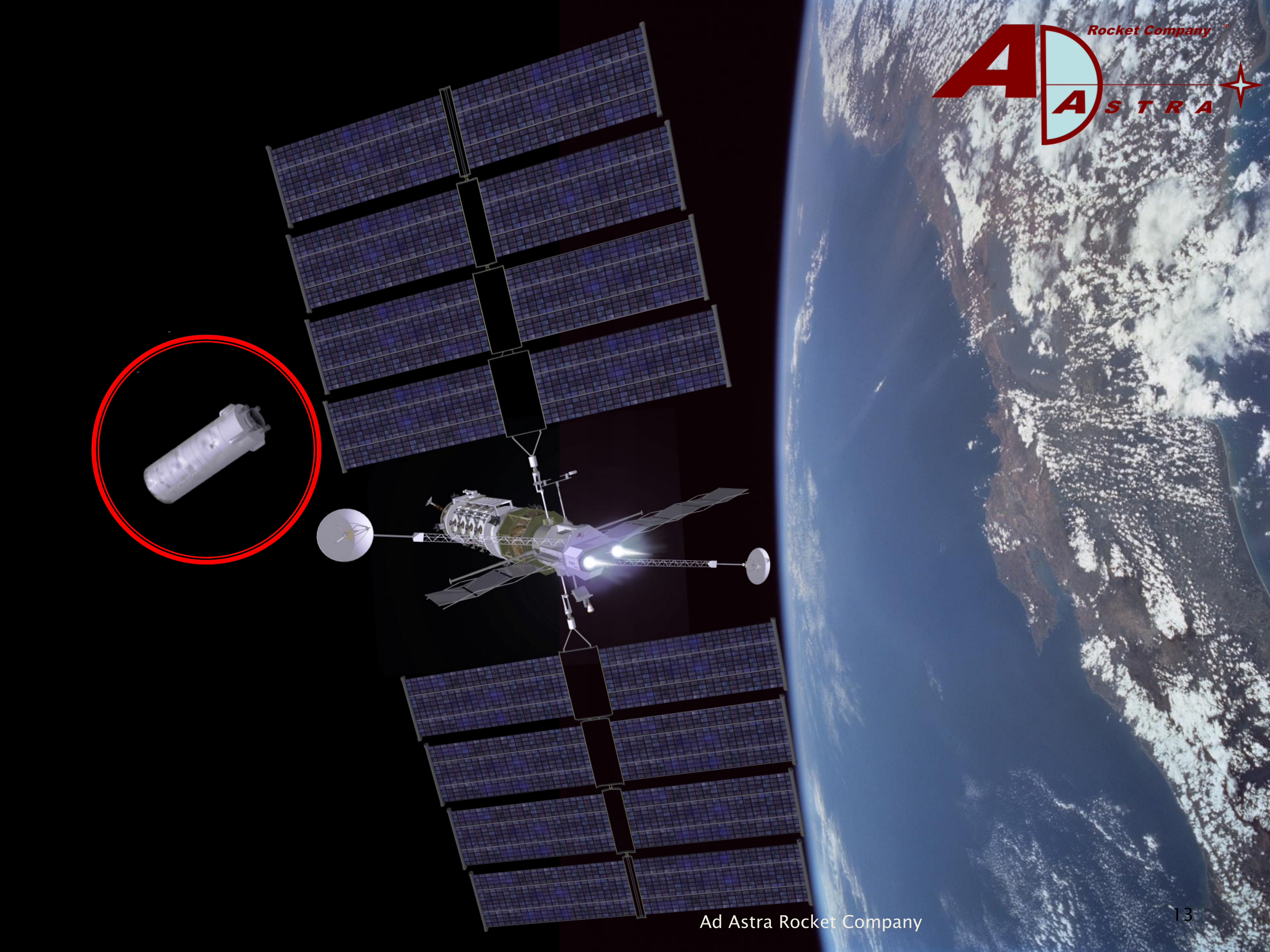
Orbital Debris Mitigation

- Number grows from collisions but can be stabilized removing ~5 large objects/ year
- Two 200kW SEP VASIMR® orbital tugs can accomplish this





Looks only at debris larger than 10 cm. Amount of debris between 1 and 10cm is 500,000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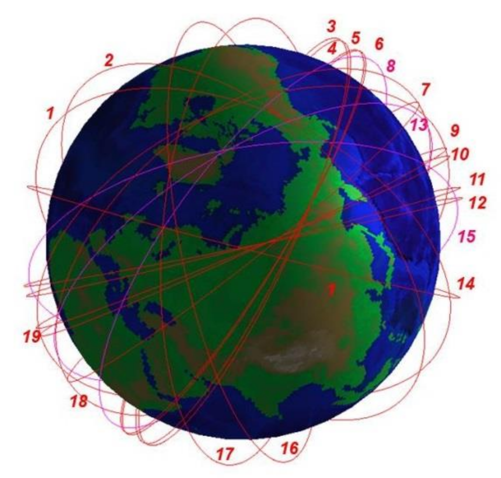
The Mission Tradeoffs

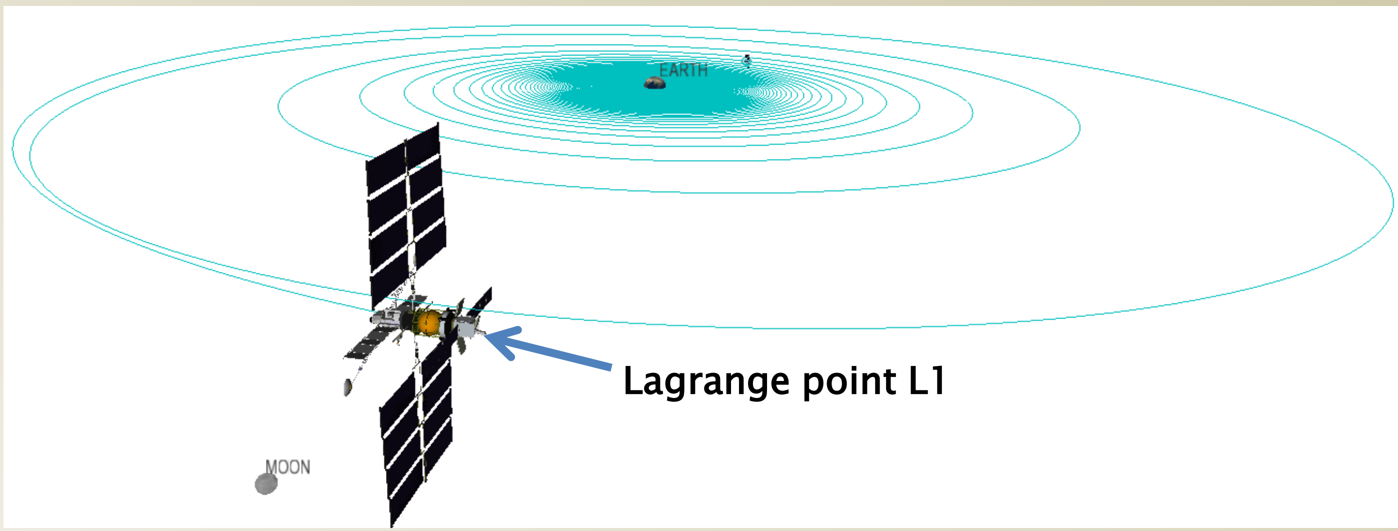
	Technology	Propellant	I_{sp}	Mission time	IMLEO	Cost
1	Hall Thruster	Xenon	3000	10.5 y	80 t	$800M
2	VASIMR®	Argon	5000	9 y	30 t	$300M
3	VASIMR®	NH3	7500	10 y	20 t	$200M

Example: Initial Mass in Low Earth Orbit (IMLEO) and mission time required to remove 19, 8.3 ton "Zenit" SL-16 rocket upper stages in 19 different high inclination orbits.



VASIMR 400 kW Solar Electric Space Tug for Cargo Delivery from LEO to L1

- Mounting interest for L1 as staging point near Moon for deep space missions
- Support of this outpost needs to be (economically) sustainable
- chemical propulsion not cost effective (low payload capability=high cost)
- IMLEO is limited by foreseeable launch capability (~50 t to LEO)
- Study assumes 400 kW VASIMR solar electric propulsion
- Ad Astra is conducting a mission study based on potential outpost mass



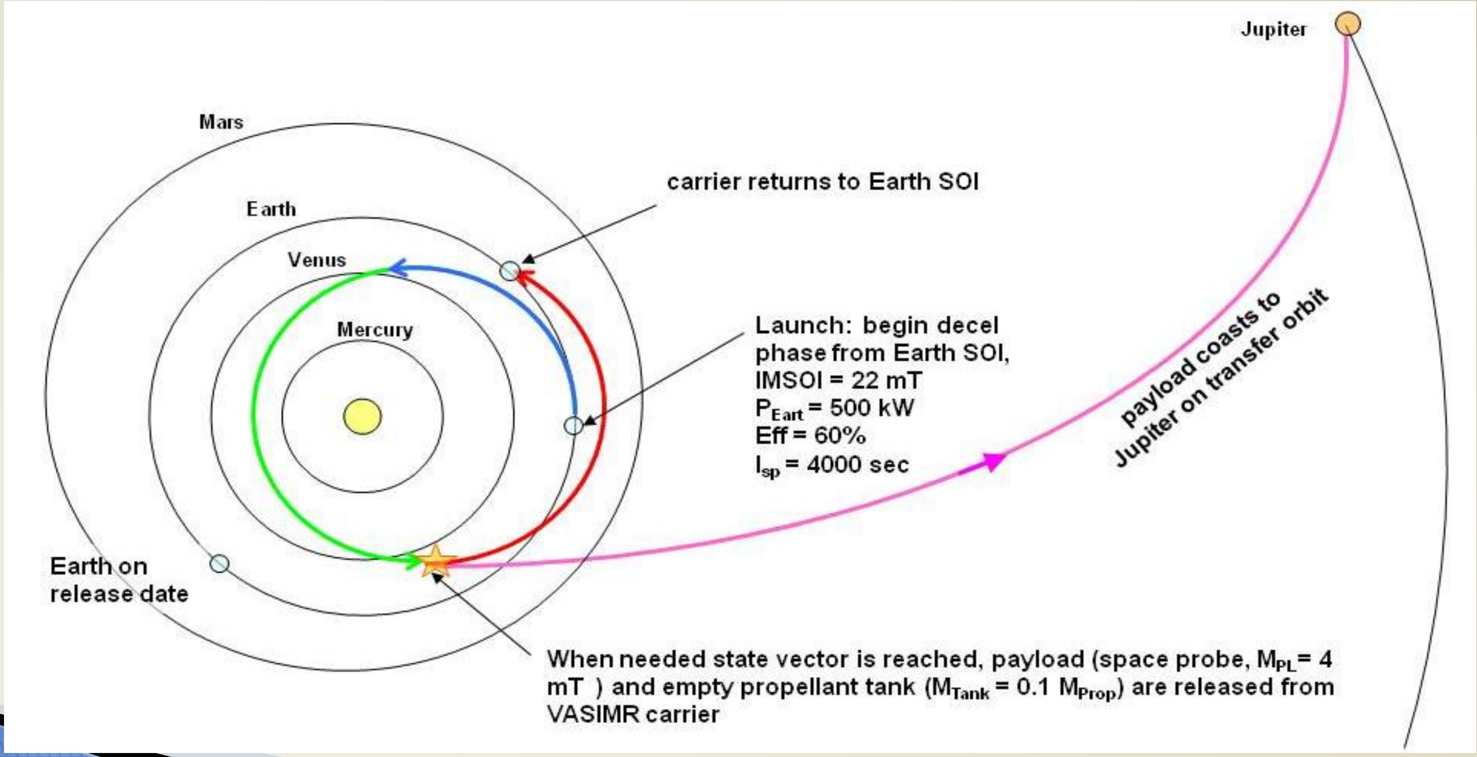
Isp [sec]	IMLEO (Mass Budget [t])	Prop(LEO-L1)	PayLoad	IML1	Prop(L1-LEO)	FMLEO	LEO-L1 (Time [days])	L1-LEO	mdot [kg/sec]	DelV[m/sec] LEO-L1
5000	50	6.3	37.5	5.6	0.7	4.8	363	41	0.00020	6,556
2500	50	12.0	30.3	6.5	1.6	4.8	173	22	0.00080	6,652
1500	50	18.8	21.1	8.2	3.1	4.8	98	16	0.00222	6,811
450	50	29	15	6	chem one way only		4	N/A	N/A	3800
350	50	33	10	7	chem one way only		4	N/A	N/A	3800

VASIMR® Deep Space Catapult

Primary propulsion for a growing market of deep space planetary missions carrying exploratory robots. Payload capacity is bound by launch capability and cost.

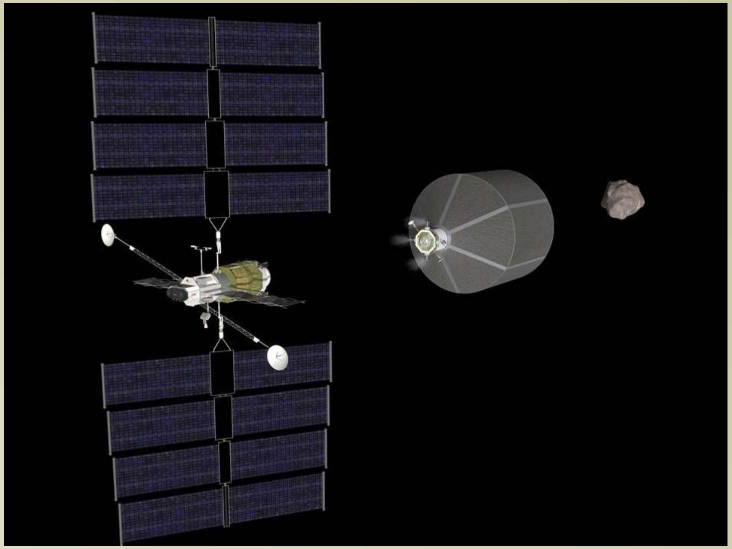
Ad Astra's fast payload delivery approach utilizes a VASIMR® solar electric space tug using a solar power boost trajectory. The tug is ultimately recovered for multiple uses.

Example: a 22 t solar-electric, VASIMR® driven spacecraft, starting at the Earth Sphere of Influence, delivers a 4,000 Kg payload to Jupiter in about 2.8 years (for comparison: NASA's 3,625 kg Juno spacecraft will take over 5 years to reach Jupiter)



Asteroid Retrieval

- Assume 1300 ton asteroid (ref. Keck Institute for Space Studies)
- Time value of money is important factor

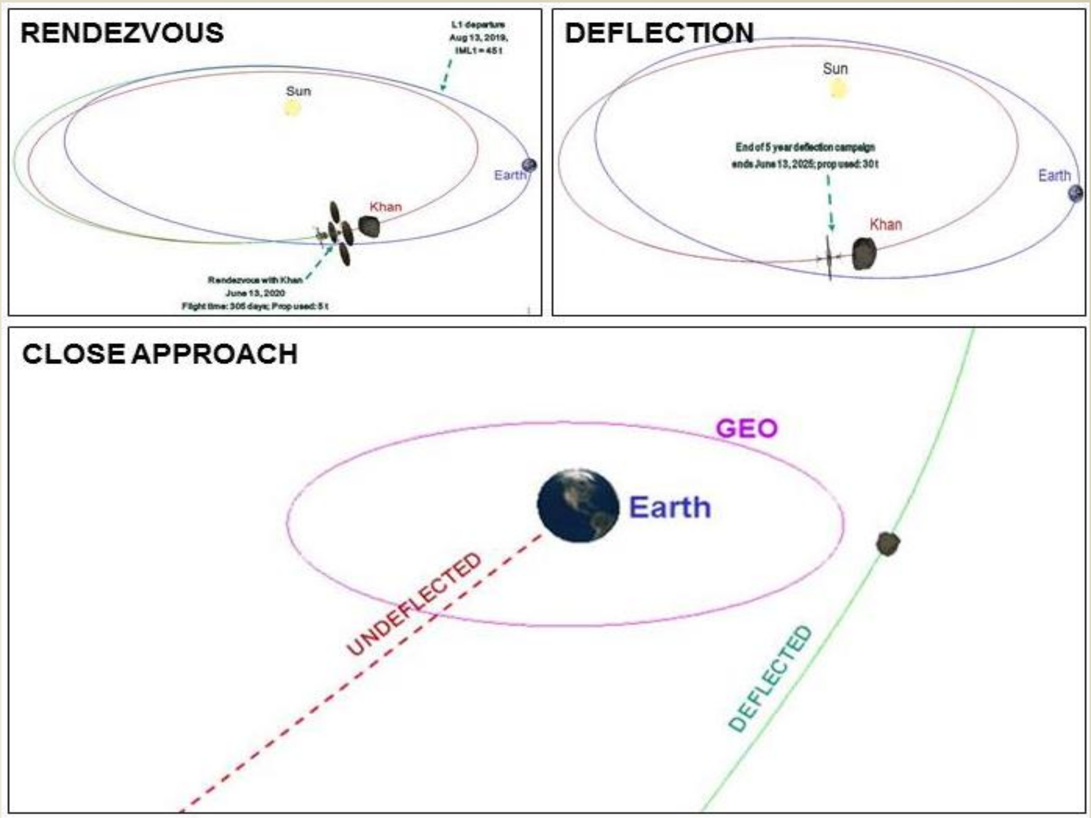


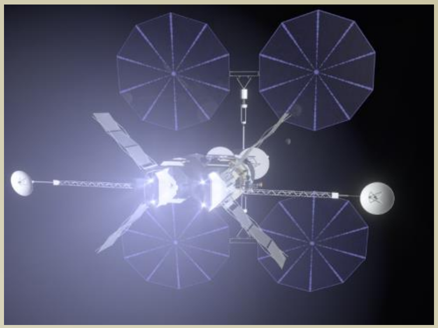
Concept of a 200 kW VASIMR® engine adapted to KISS study NEA retrieval module

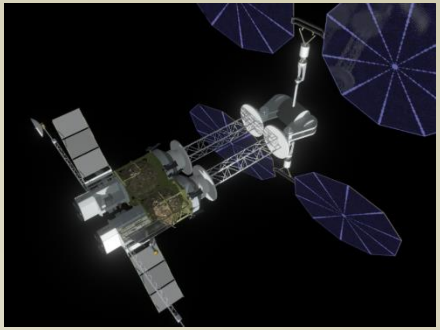
Type	Fuel Type	Fuel Cost	Years	2012 Cost	Final Cost
VASIMR® VF-200	Argon	$5 per kg	2.0	$3.3B	$5 B
Hall Thruster 40Kw	Xenon	$1000 per kg	10.1	$2.6B	$20 B

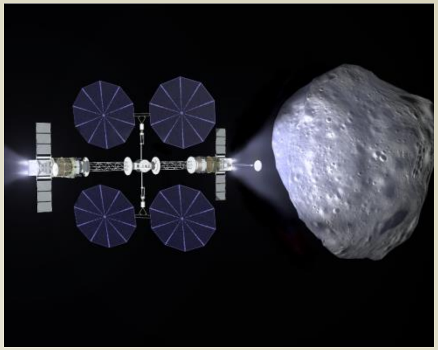
Asteroid Deflection

Deflecting a 7 million ton, 150 m asteroid on a collision course with Earth









Chelyabinsk meteor,
15th February 2013