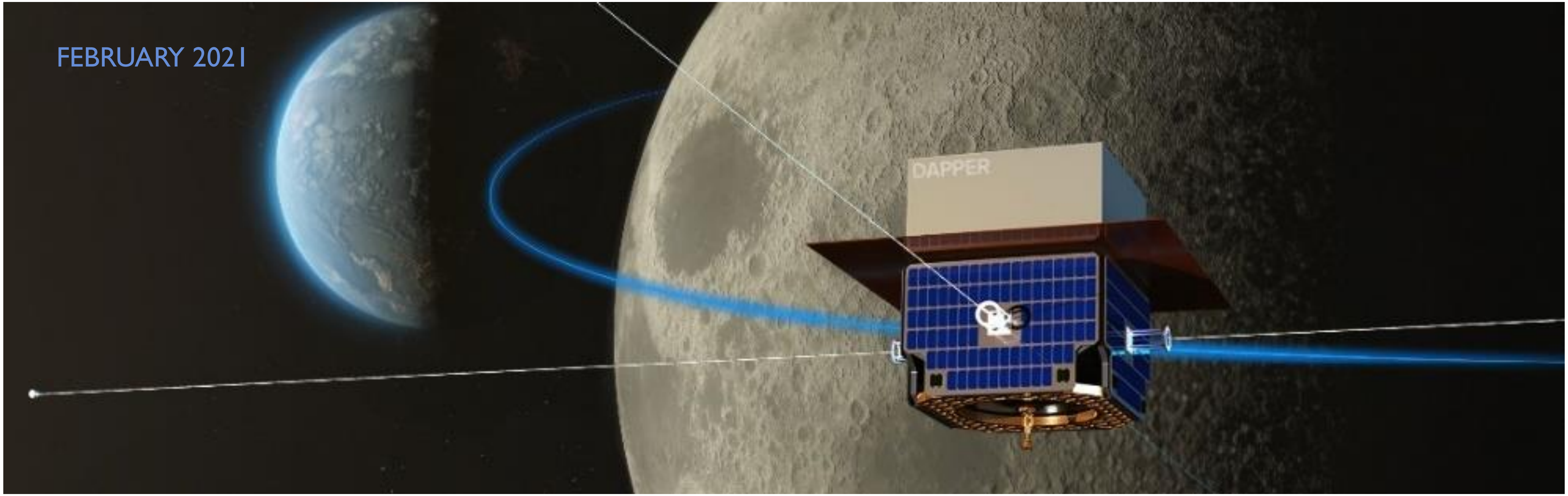


SPACEPORT SUMMIT: BUILDING OUT THE SOLAR SYSTEM

IAN FICHTENBAUM

CEO, BRADFORD SPACE

BRADFORD FULL STACK SPACECRAFT DEVELOPMENT

- Trusted for quality space systems
- Proprietary **high-performance propulsion** and avionics technologies and products
- Over 2000 products launched to space
- 44k sq ft of facilities
- Over 75 engineering, R&D, production and admin staff
- Close relationships with space customers around the world
- www.bradford-space.com

VALUE IN SPACE IN TWO RINGS

Ring 1: Historical value in the GEO belt

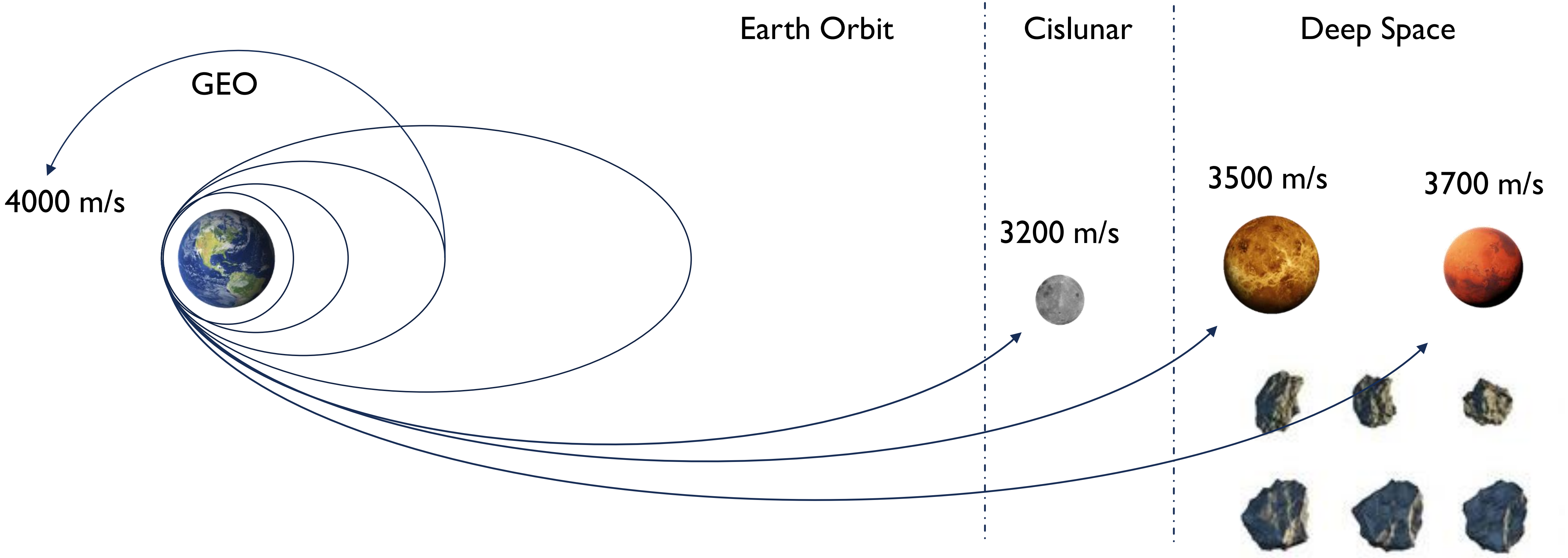
Ring 2: Future Value in the rings of the Inner Solar System

- Transport
- Navigation
- Communications
- Surveillance
- Science
- Exploration
- Resources

An abundance of value
But you first need to get there

Asteroid map by Eleanor Lutz

THE INNER SOLAR SYSTEM ON DEMAND
GOING FROM LEO TO ANYWHERE YOU WANT



HOW TO GET THERE (COST EFFECTIVELY)

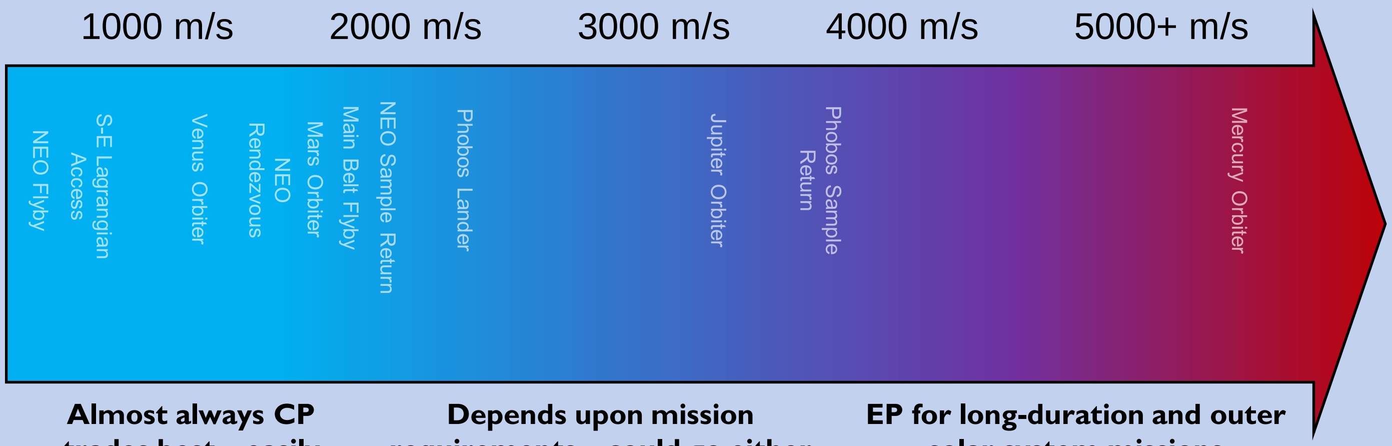
THE CP VS. EP DEBATE: OUR HUMBLE OPINION

Building the Solar System will require a new class of spacecraft

- Launch system adaptability
- “Off the shelf” modular avionics stack for deep space (nav, comms, attitude)
- Lots of delta-V
- Lots of thrust – which means chemical propulsion or lots of power

Nuclear power or propulsion not cost effective yet, so high performance chemical systems have to do

Delta-V beyond C3 = 0



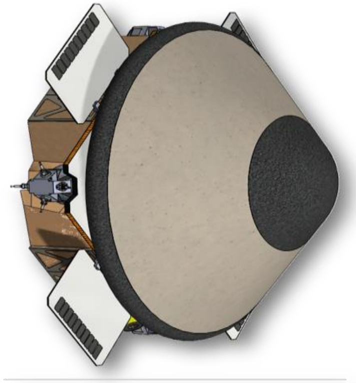
Almost always CP trades best – easily achievable

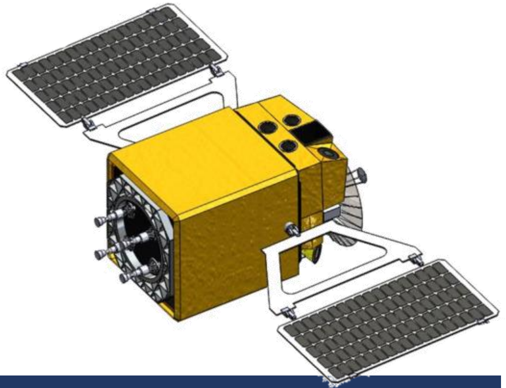
Depends upon mission requirements – could go either way

EP for long-duration and outer solar system missions

- **EP drives time-of-flight, and time-of-flight drives mission cost**
  - High-thrust spacecraft are “fire and forget”. Minutes-to-hours-long burns and then **upset-tolerant cruise**
  - CP spacecraft designs have simplified testing and qual campaigns
- **Pointing and power requirements are reduced**
- **Fast deployment of infrastructure and deployment on demand**

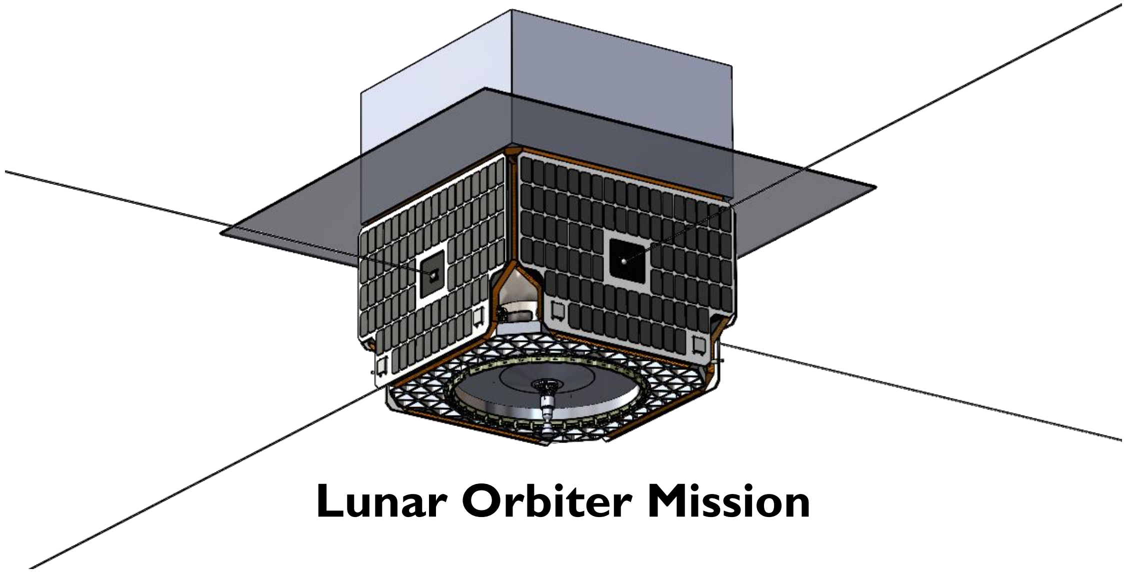
www.ecaps.space





MULTIPLE SOLUTIONS EXIST, BUT BRADFORD MONOPROP ECAPS PROPULSION FITS LOTS OF IMPORTANT REQUIREMENTS (AND HAS PLENTY OF HERITAGE)

FAST AND NIMBLE PLANETARY EXPLORATION - CASE STUDY



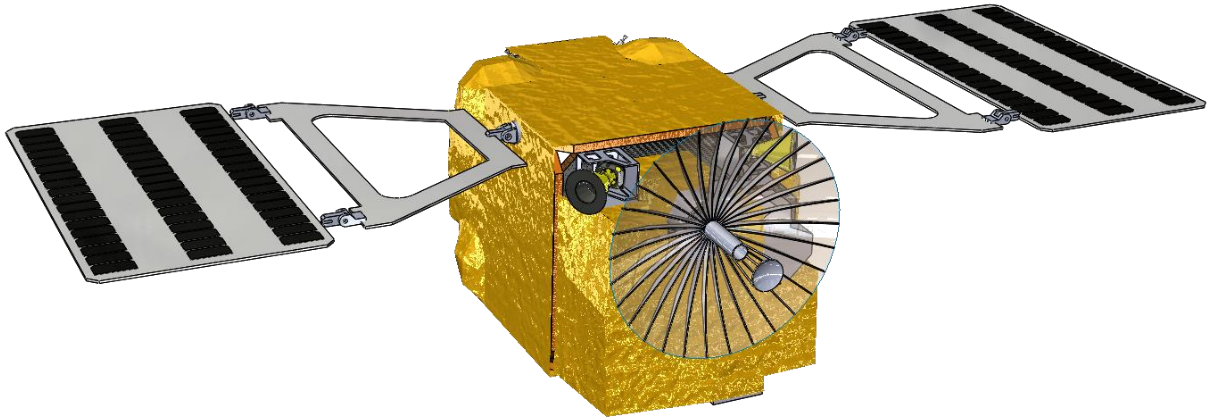
Lunar Orbiter Mission

Rideshare to cislunar space – self-propelled to science orbit

Bus provides all payload services – power, pointing, comms etc.

Comfortably fits within SIMPLEx cost envelope

Two-year science mission in 125 km Low Lunar Orbit



Venus Orbiter Mission

Maneuvers to Hohmann transfer to Venus (Venus Transfer Insertion)

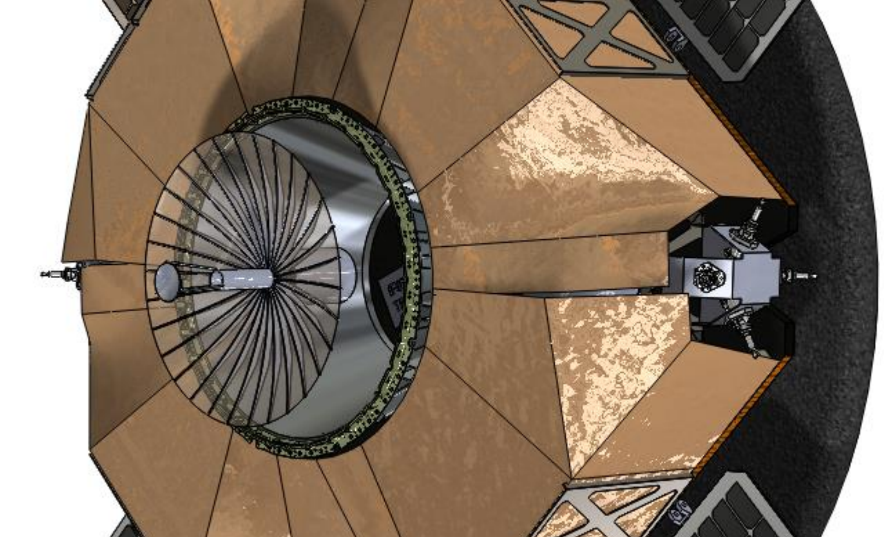
176 day cruise to Venus – 10 months less than EP-driven system

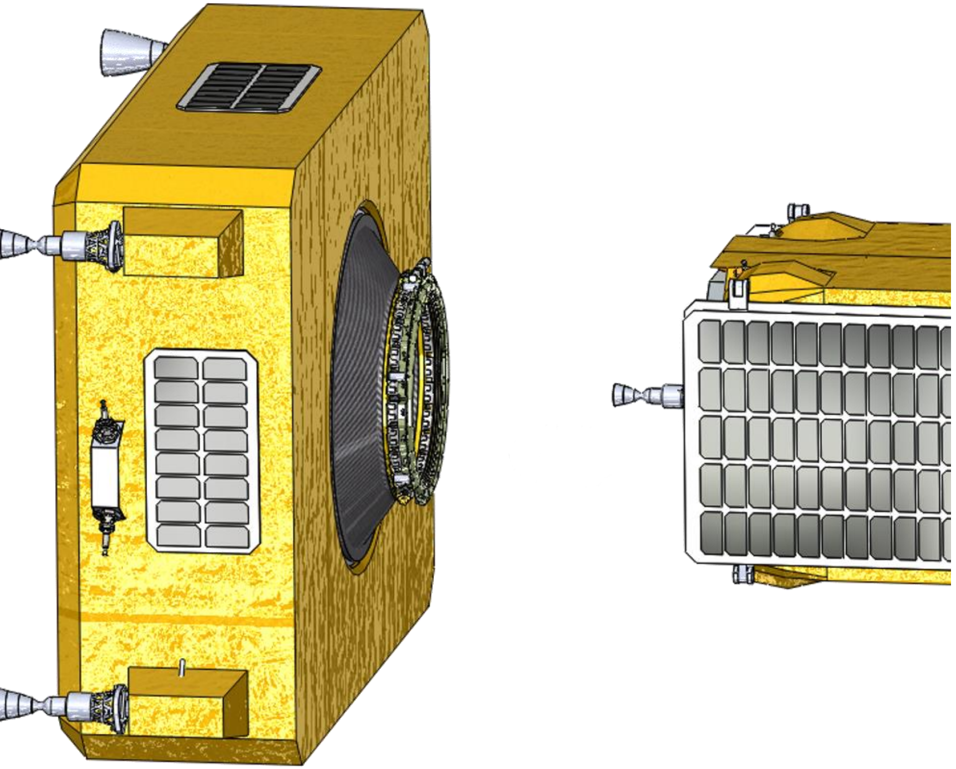
Venus Orbit Insertion and propulsive lowering to 150 Mm x 2 Mm altitude

Circular orbits at 150 Mm or 300 Mm

4+ years at Venus: 122 orbits in first year baseline mission

Up to 3-years of mission extension





FAST AND NIMBLE TRANSPORTATION

Earth → Mars space transport

- “Squire” orbital transfer stage for Earth to Mars transit
- 1 kb/s downlink + 50W power availability throughout 11-month Mars transfer
- Handles cruises launched outside of optimal transfer windows, to exploit rideshare opportunities

LEO → MEO, GEO and cislunar space

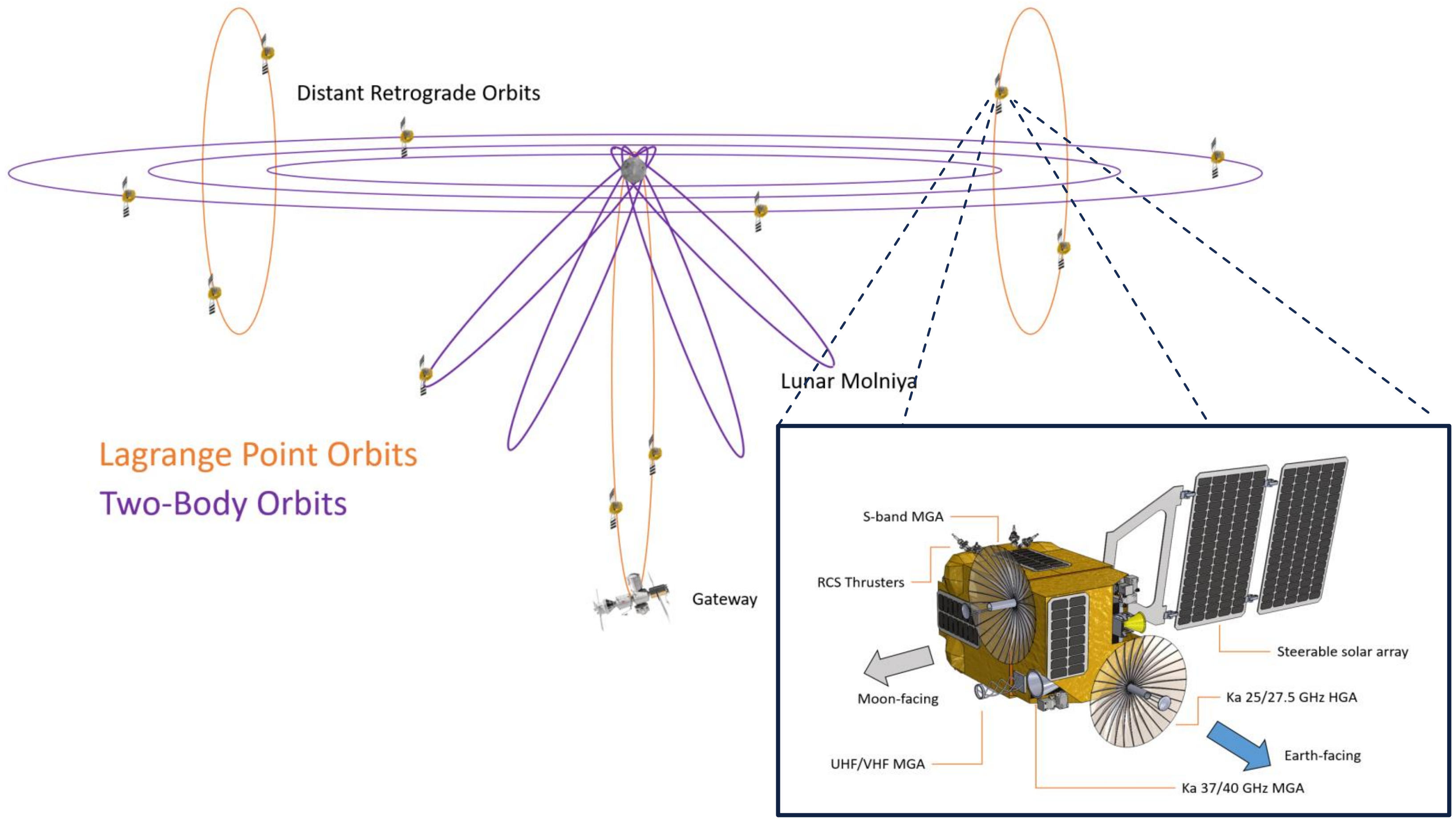
- “SqRt” rideshare space tug
- Up to 3200 m/s dV @ 80kg satellite payload
- High thrust → fast response and quick radiation belt transition

The “space tug” as a commoditized service, implemented with proven and cost-efficient technologies

RAPID DEPLOYMENT LUNAR COMMUNICATIONS NETWORK

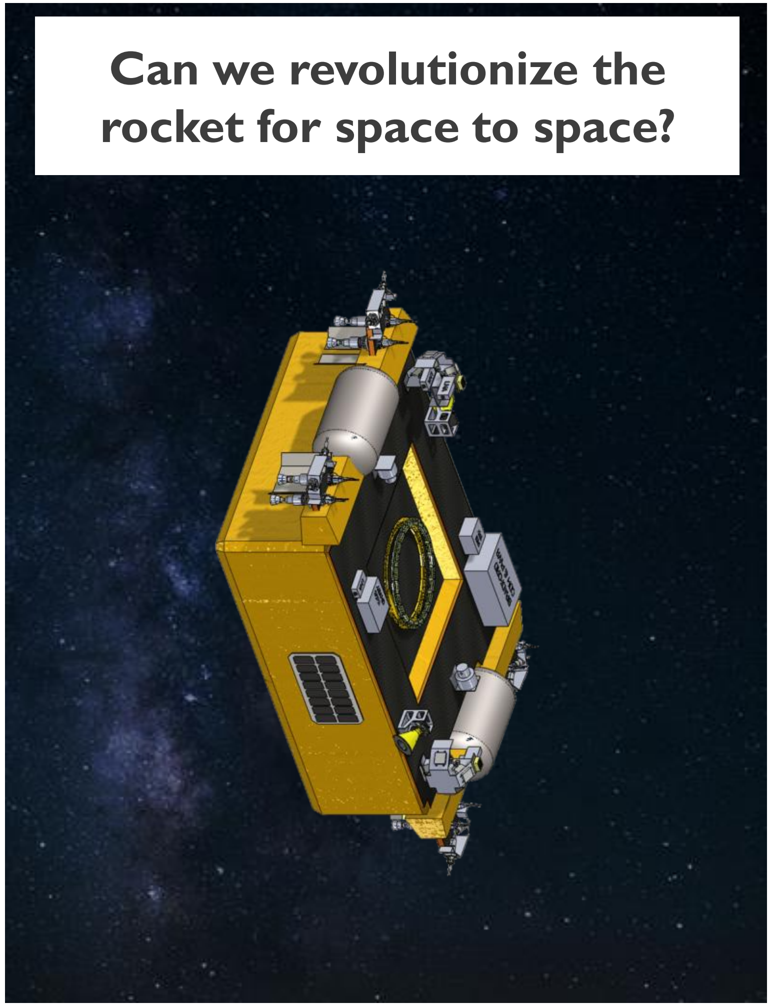
- 180 kg, 200 W, "Explorer" spacecraft capable of carrying up to 40 kg of communication payload
- **Deployment from LEO. 1 month to DRO or NRHO**
- Full quality coverage of the Moon with 6 Explorer vehicles.
  - 2 @ EML-1 halo
  - 2 @ EML-2 halo
  - 2 @ Southern NRHO.
- Enough propellant for 5 years of lifetime or orbit relocation
- **Initial 2 Explorer lunar deployment for ~$50m**

	Band	Purpose	Uplink (to Relay)		Downlink (from Relay)	
Earth – Relay	Ka	Earth Trunk	40-40.5 GHz		37-38 GHz	
Relay - Moon	UHF	Lunar Surface Users	0.435-0.450 GHz	5 kb/s	0.39 – 0.405 GHz	10 kb/s
	S	Lunar Surface Users	2.2-2.29 GHz		2.483-2.5 GHz	5 kb/s
	Ka	Lunar Orbital & Surface Users	27.0-27.5 GHz	2.5 Mb/s	23.15 – 23.55 GHz	5 kb/s



WHAT'S NEXT?

As SpaceX revolutionized the rocket from Earth to space



Can we revolutionize the rocket for space to space?