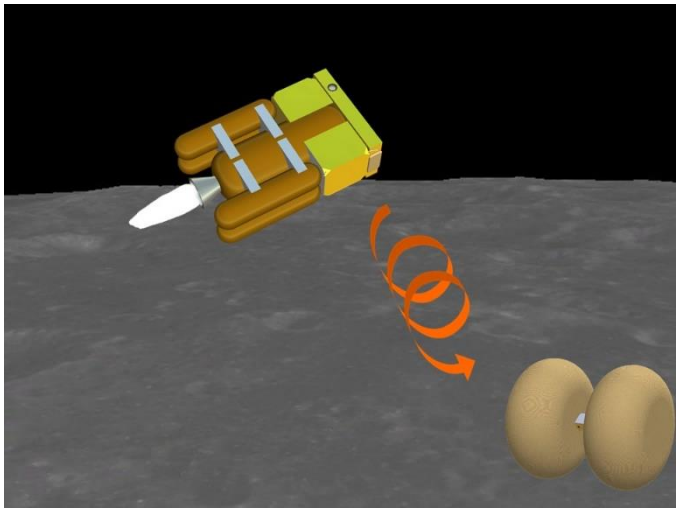
SLS EM-1 secondary payload

OMOTENASHI

(Outstanding MOon exploration TEchnologies demonstrated by NAno Semi-Hard Impactor)

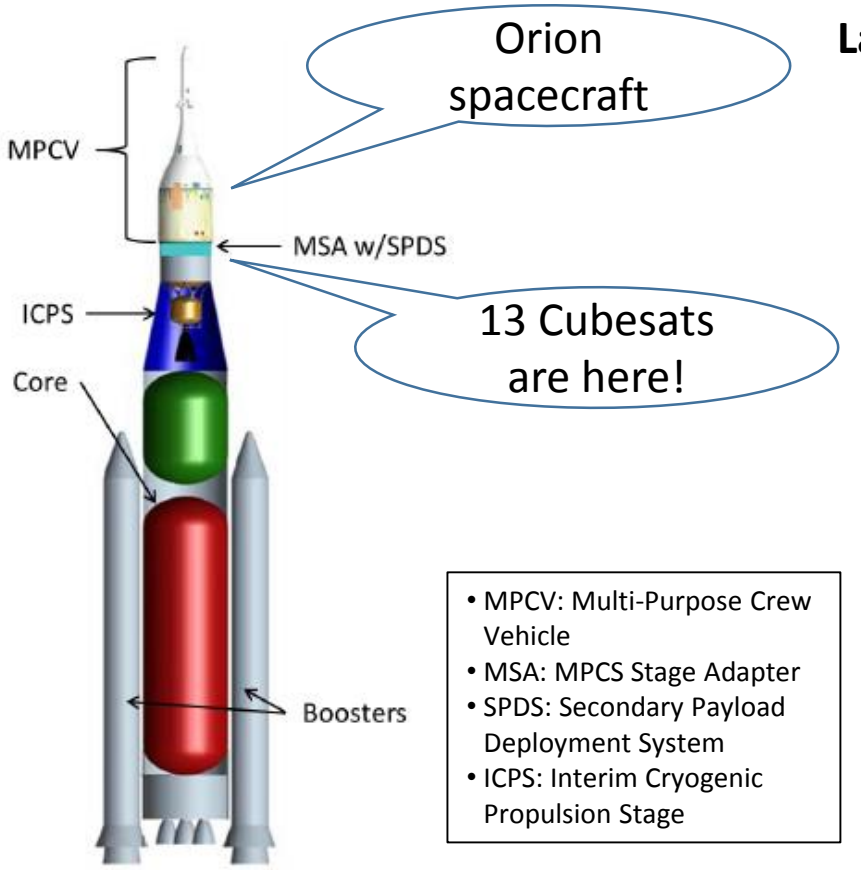


The smallest moon lander
launched by
the most powerful rocket in the world

* “Omotenashi” means welcome or hospitality in Japanese. It is one of campaign messages for Tokyo Olympic 2020.

2016/10/29

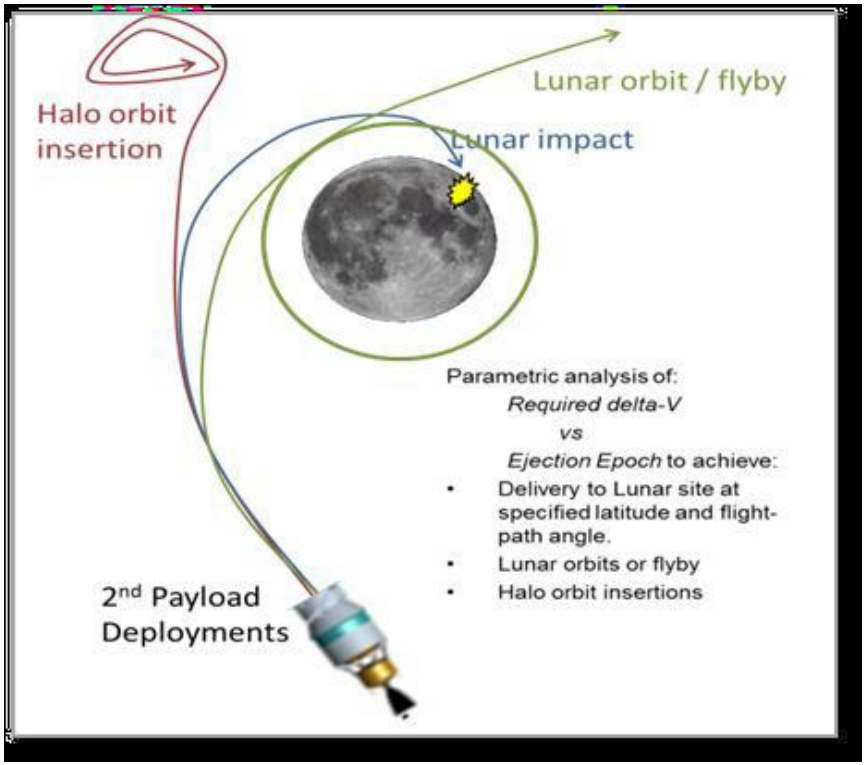
NASA proposal（From SLS Secondary Payload User's Guide）



- MPCV: Multi-Purpose Crew Vehicle
- MSA: MPCS Stage Adapter
- SPDS: Secondary Payload Deployment System
- ICPS: Interim Cryogenic Propulsion Stage

EM-1 configuration

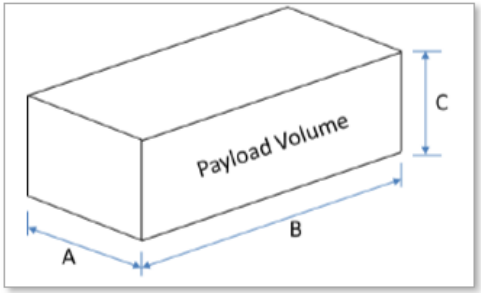
Launch date: 2018 (TBD)



SLS orbit

Size of the secondary payload

Deployer	A		B		C		Volume		Mass	
	in	mm	in	mm	in	mm	in^3	mm^3	lbs	kg
6U	9.41	239.00	14.41	366.00	4.45	113.00	603.41	9,884,562	30.86	14.00
12U	9.41	239.00	14.41	366.00	8.90	226.00	1206.82	19,769,124	44.73	20.29



Mission objectives

- Development of the smallest lunar lander in the world and demonstrate the feasibility of the hardware for distributed cooperative nano-exploration system, which Space Exploration Innovation Hub of JAXA plans to realize. Small landers will enable multi-point exploration which is complimentary with large-scale human exploration system. And also they promote the participation of private sectors.

  -> Demonstration of a nano-lander which can be easily carried in any robotic or human orbiters or landers.

- Observation of radiation and soil environment of the moon surface by active radiation measurements and soil shear measurements. (candidate) Especially, the measurement of radiation environmental parameters on the Moon surface is essential to support radiation risk assessments for astronauts and establish a benchmark for space radiation models for human space activities on the Moon.

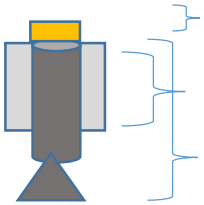
  -> Observation of radiation and soil environment are listed in SKG (Strategic Knowledge Gap) of ISECG (International Space Exploration Coordination Group).

Mission scenario

Observe radiation environment and soil mechanics with a Nano-lander and reduce the risk of human lunar exploration.

Spacecraft configuration

Target total mass 14 kg

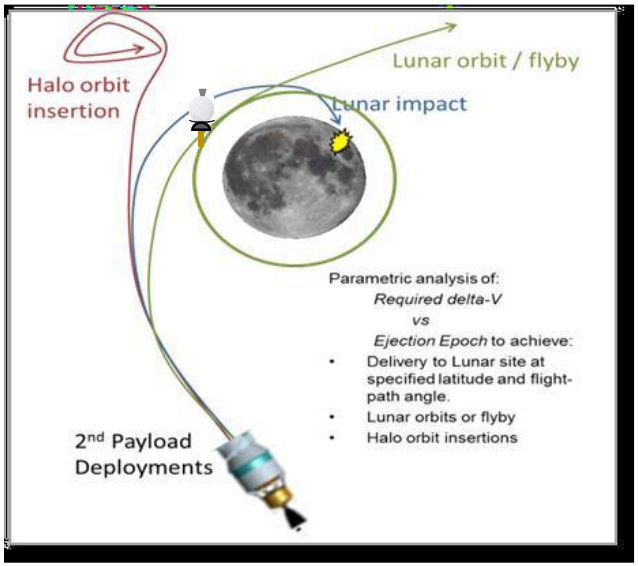


Nano lander including connector, shock damper, etc. 1.0 kg

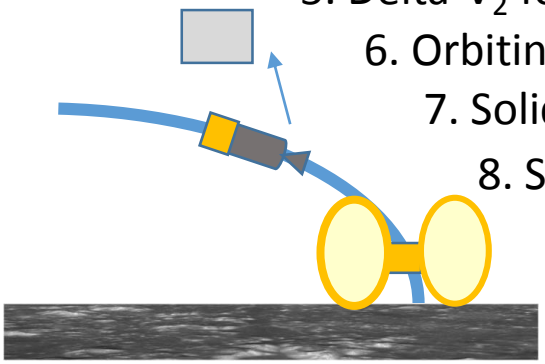
Orbiter incl. gas jet propulsion 7.0 kg

Solid motor. 6.0 kg

Mission sequence



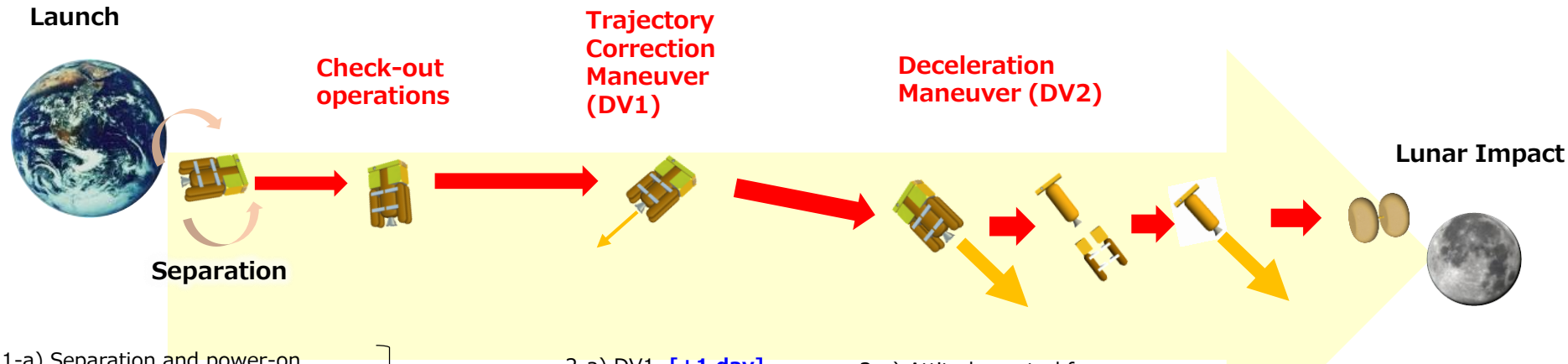
1. Separation from SLS
2. Attitude acquisition
3. Delta-V_1 to moon impact orbit
4. Attitude acquisition and spin-up for solid motor firing
5. Delta-V_2 for deceleration firing
6. Orbiting module jettison
7. Solid motor jettison
8. Semi-hard landing (about 30 m/s)



9. Observation of radiation and soil environment

Concept of Operations Overview

Currently, separation at 26,700 km altitude (4.5 hours from the launch) is considered.



1-a) Separation and power-on.

1-b) Detumbling, sun-pointing. **[+TBD min]**

Automatic sequence

1-c) Initial health checks. power/thermal/comm./attitude Control/propulsion. **[+TBD hour]**

Initial Orbit Determination (OD)

2-a) DV1. **[+1 day]**

2-b) Monitoring the achievement of DV1 by RARR. **[+1~3 days]**

3-a) Attitude control for Deceleration Maneuver (DV2). **[~5 days]**

3-b) Ignition of solid motor.

3-c) Separation of Orbiting Module.

3-d) Solid motor burn-out.

3-e) Surface probe separation.

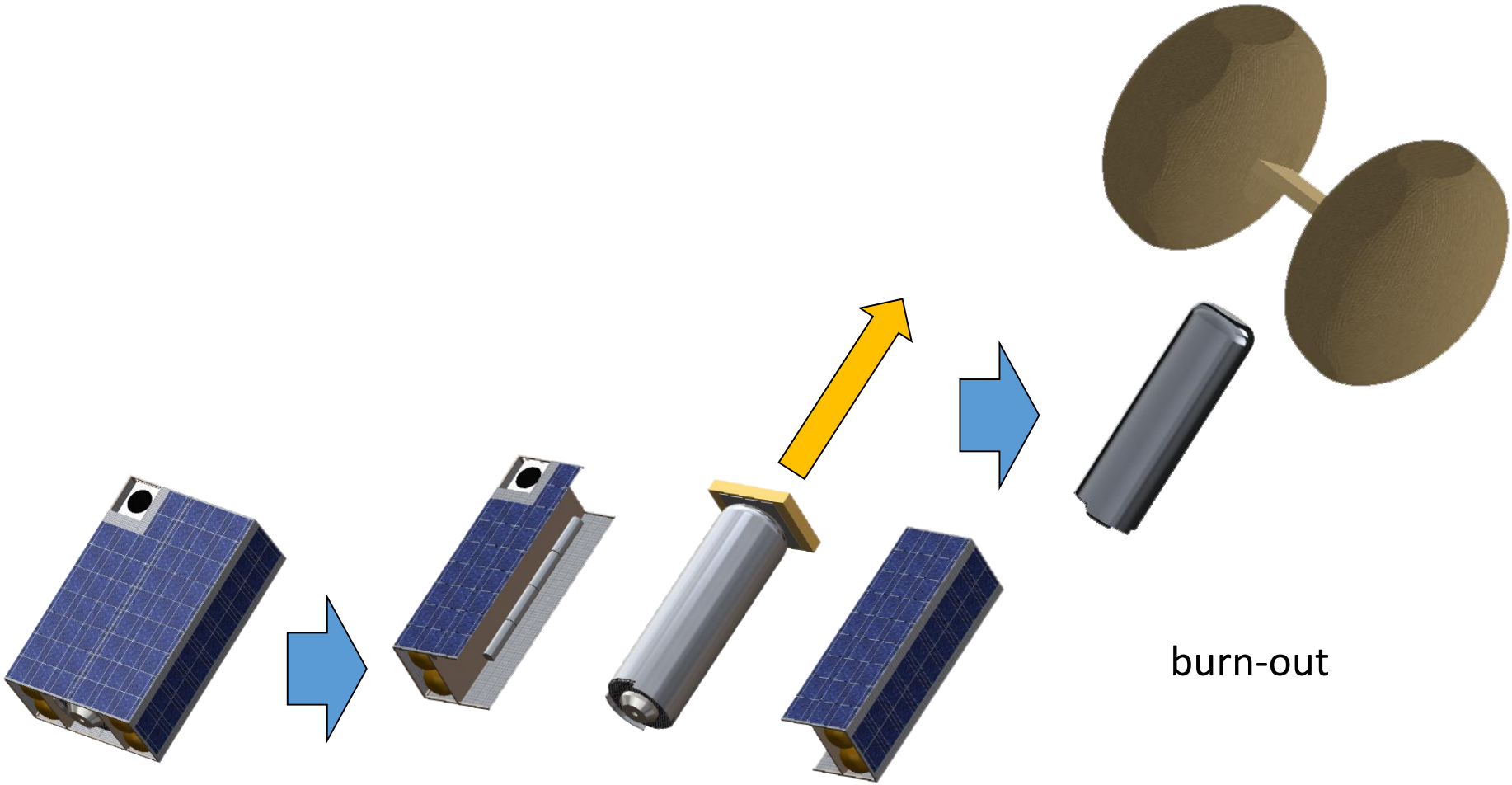
1) Brief check-out of bus systems

2) Trajectory Correction Maneuver

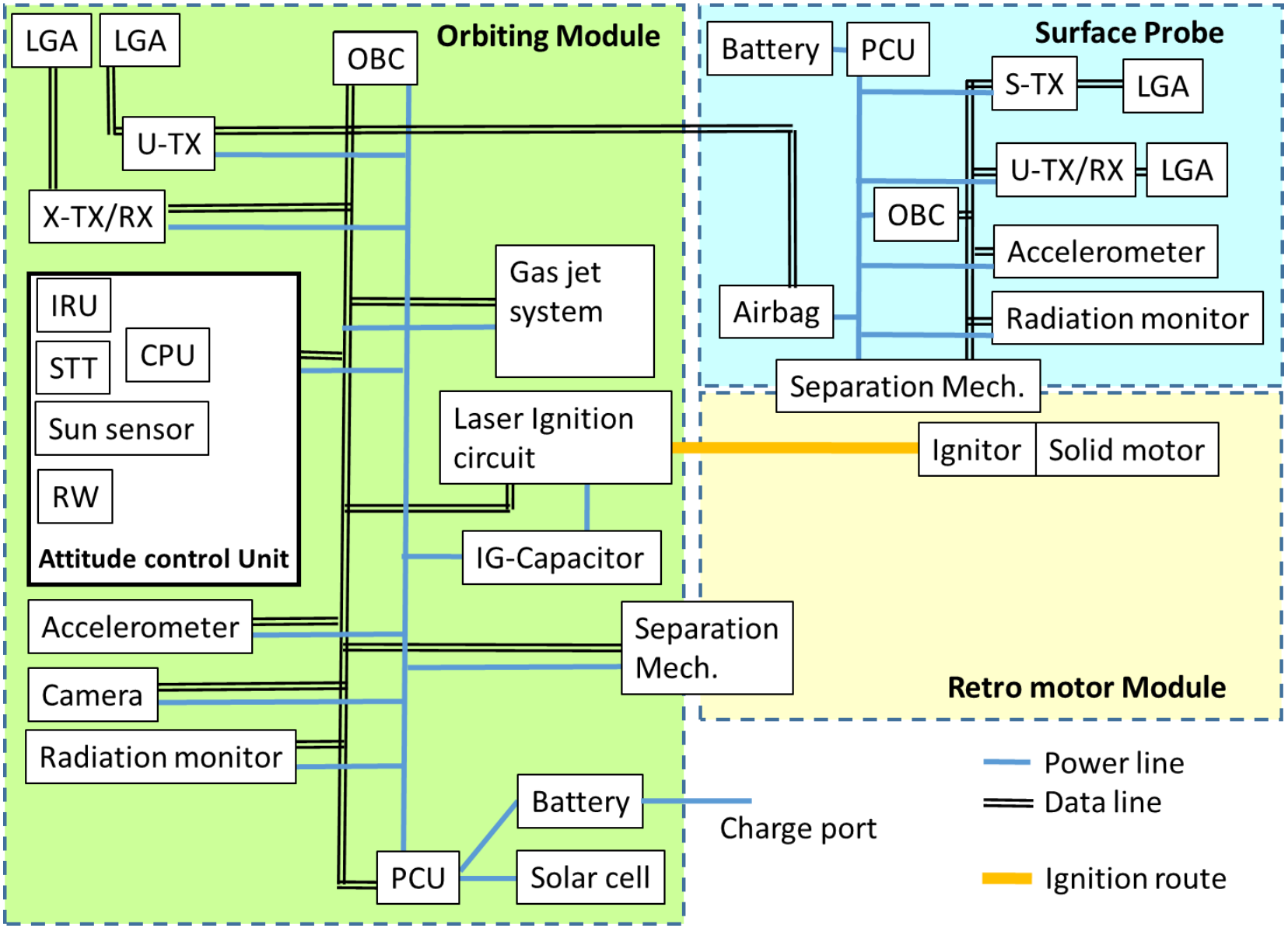
3) Deceleration Maneuver

[ ]: Time after separation

OMOTENASHI configuration



OMOTENASHI block diagram (tentative)



Main specification (TBD)

Payload	• Radiation monitor (OM and SP) • Shock acceleration measurement (SP)
Mechanical& Structure	6U, 14kg, consists of three modules, Orbing Module, Retro motor Module, Surface probe.
Propulsion	• Solid motor (2500 m/s TBD) • Gas jet (N_2, 20 m/s TBD)
Avionics	• 2 On Board Computer (for OM, SP)
Electrical Power System	OM • Solar cell (body mounted) 30W max, 15W spinning • Secondary battery 30 Wh (TBD) SP • Primary battery 30 Wh (TBD)
Telecom	OM • X-band Up Link • X-band Down Link • P-band Down Link (Amateur Radio Frequency) • Chip Scale Atomic Clock SP • S-band Downlink • P-band Downlink • P-band Uplink
Attitude Control System	• Sun Acquisition: 0.1 deg (TBD) • Three axis stabilized: 0.01 deg (TBD) • Spin: 300 rpm (TBD)

Power budget (TBD)

Orbing Module

- Solar Array (Body mount)　20 W
- Battery (Li-ion Secondary cell) 30 Wh
- Power Consumption 20 W

Surface Probe

- Batter（Primary cell）　30 Wh
- Power Consumption　15 W