Chandrayaan-3

An Overview

LVM3-M4/CHANDRAYAAN-3 MOON MISSION

Indian Space Research Organisation

As Space Tutor for School Children

CHANDRAYAAN-3

- Chandrayaan-3 is a follow-on mission to Chandrayaan-2 to demonstrate end-to-end capability in safe landing and roving on the lunar surface.
- It consists of Lander and Rover configuration.
- It will be launched by LVM3 from SDSC SHAR, Sriharikota.
- The propulsion module will carry the lander and rover configuration till 100 km lunar orbit.
- The propulsion module has Spectro-polarimetry of Habitable Planet Earth (SHAPE) payload to study the spectral and Polari metric measurements of Earth from the lunar orbit.
    - The launcher identified for Chandrayaan-3 is GSLV-Mk3 which will place the integrated module in an Elliptic Parking Orbit (EPO) of size ~170 x 36500 km.

CHANDRAYAAN-3

Chandrayaan-3 consists of an indigenous

- **Lander module (LM),**
- **Propulsion module (PM) and**
- **Rover**

Objective:

- **Developing and demonstrating new technologies required for Inter planetary missions.**
- **The Lander will have the capability to soft land at a specified lunar site.**
- **Deploy the Rover which will carry out in-situ chemical analysis of the lunar surface during the course of its mobility.**
- **The Lander and the Rover have scientific payloads to carry out experiments on the lunar surface.**
- **The main function of PM is to carry the LM from launch vehicle injection till final lunar 100 km circular polar orbit and separate the LM from PM.**
- **Propulsion Module also has one scientific payload as a value addition which will be operated post separation of Lander Module.**

CHANDRAYAAN-3

Chandrayaan-3 Mission Objective

The mission objectives of Chandrayaan-3 are:

- **To demonstrate Safe and Soft Landing on Lunar Surface**
- **To demonstrate Rover roving on the moon and**
- **To conduct in-situ scientific experiments.**

Advanced technologies are present in Lander such as,

1.Altimeters: Laser & RF based Altimeters

2.Velocimeters: Laser Doppler Velocimeter & Lander Horizontal Velocity Camera

3.Inertial Measurement: Laser Gyro based Inertial referencing and Accelerometer package

4.Propulsion System: 800N Throttleable Liquid Engines, 58N attitude thrusters & Throttleable Engine Control Electronics

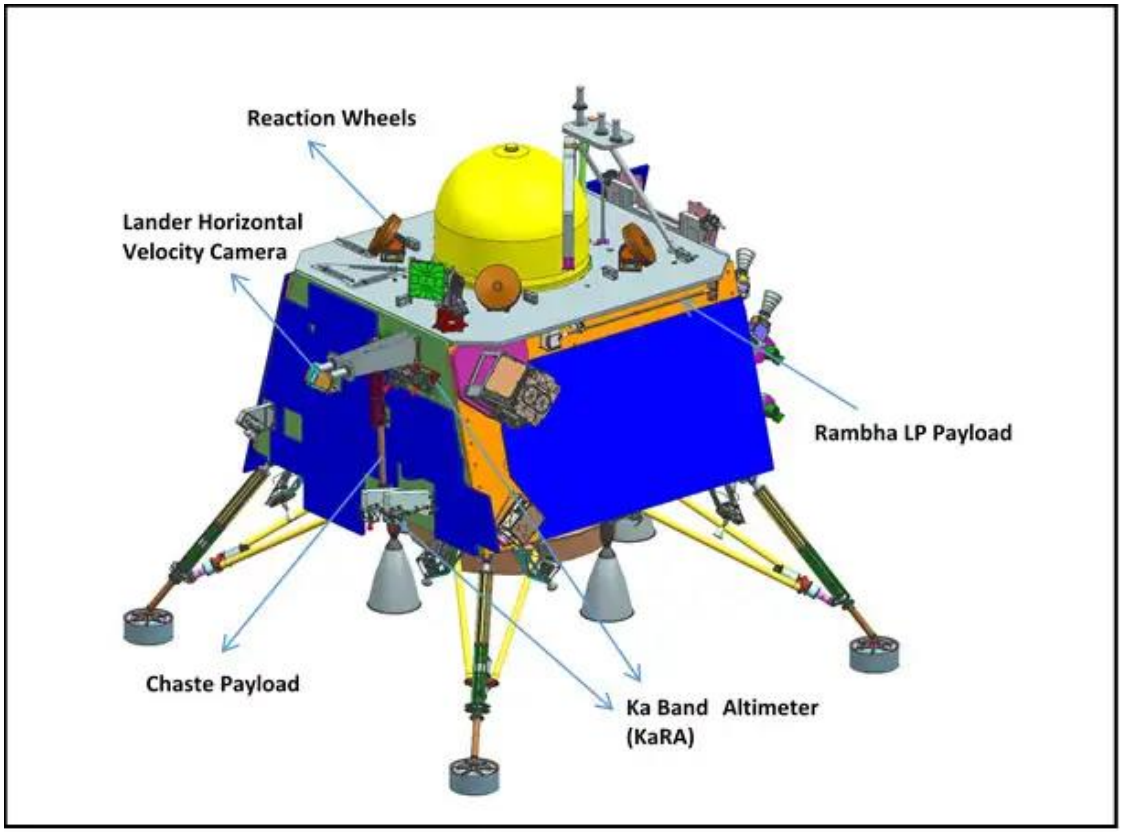
5.Navigation, Guidance & Control (NGC): Powered Descent Trajectory design and associate software elements

6.Hazard Detection and Avoidance: Lander Hazard Detection & Avoidance Camera and Processing Algorithm

7.Landing Leg Mechanism.

Lander payloads

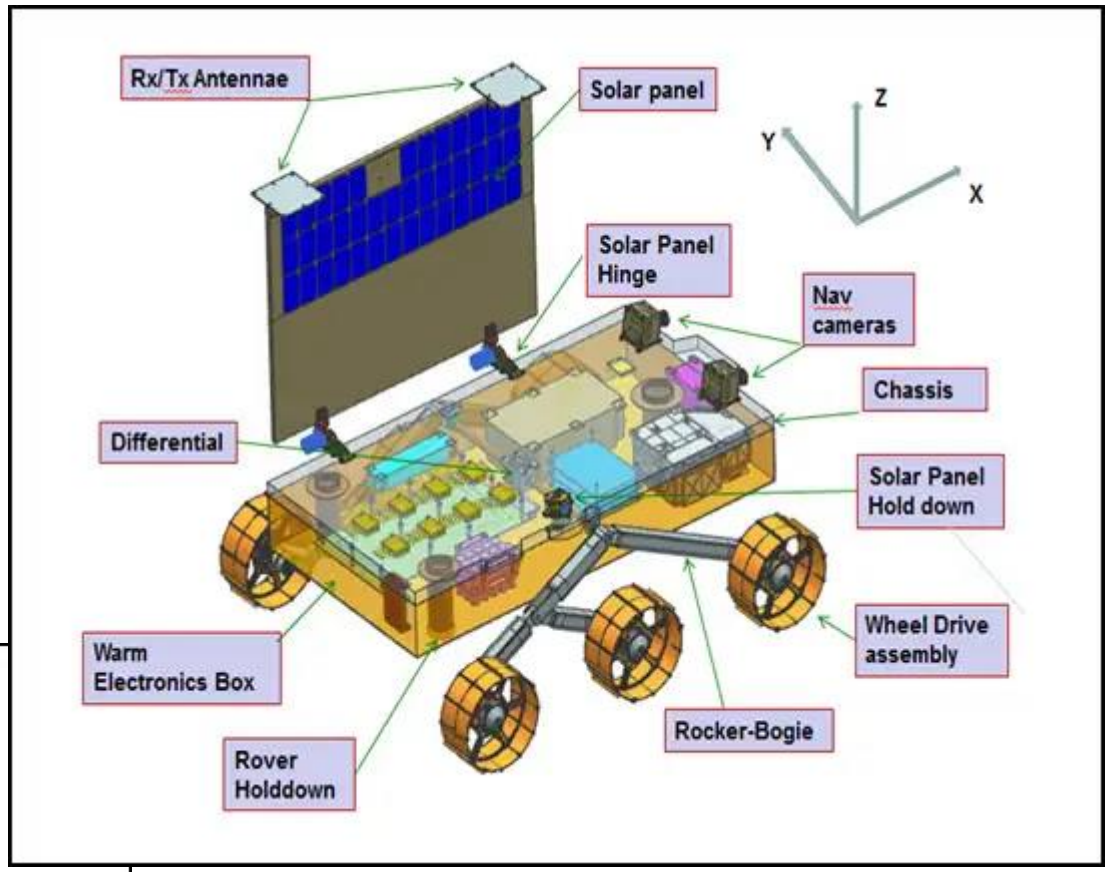
- Chandra's Surface Thermophysical Experiment (ChaSTE) to measure the thermal conductivity and temperature.
- Instrument for Lunar Seismic Activity (ILSA) for measuring the seismicity around the landing site.
- Langmuir Probe (LP) to estimate the plasma density and its variations.

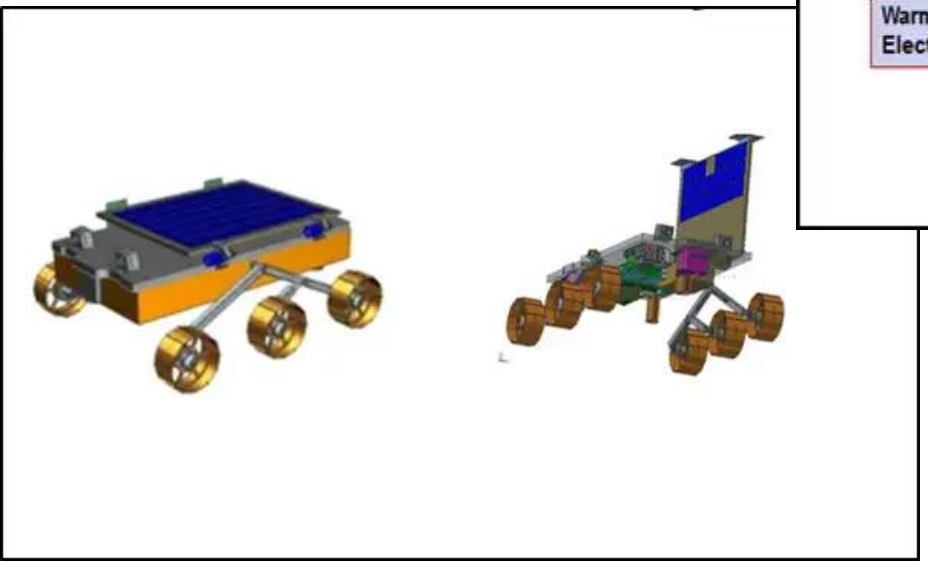


- A passive Laser Retroreflector Array from NASA is accommodated for lunar laser ranging studies.

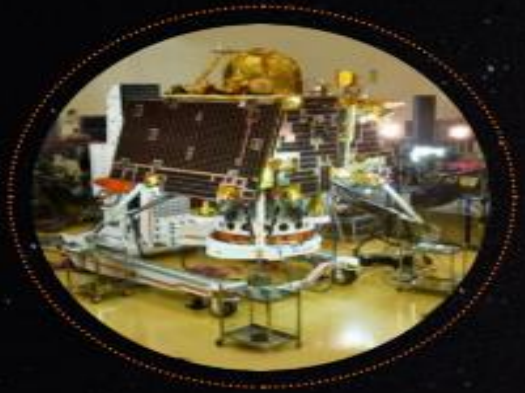
Rover payloads

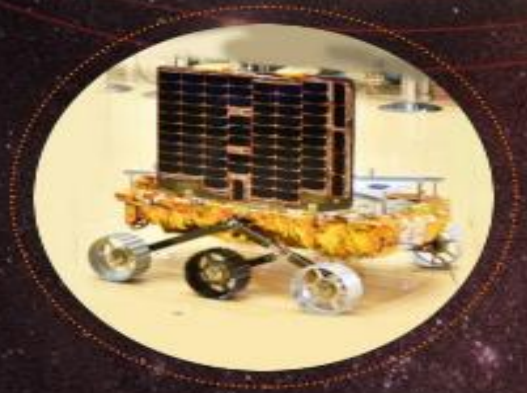
- Alpha Particle X-ray Spectrometer (APXS)
- Laser Induced Breakdown Spectroscope (LIBS) for deriving the elemental composition in the vicinity of landing site.





LVM3-M4/ Chandrayaan-3 Mission





Major Specifications of Lander

Mission life	: 1 Lunar day (14 Earth days)
Mass	: 1749.86 kg including Rover
Power	: 738 W (Winter solstice)
Payloads	: 3
Dimensions (mm^3)	: 2000 x 2000 x 1166
Communication	: ISDN, Ch-2 Orbiter, Rover
Landing site	: 69.367621 S, 32.348126 E

Major Specifications of Rover

Mission Life	: 1 Lunar day
Mass	: 26 kg
Power	: 50 W
Payloads	: 2
Dimensions (mm^3)	: 917 x 750 x 397
Communication	: Lander

Specifications for Chandrayaan-3

S/N	Parameter	Specifications
1	Mission Life (Lander & Rover)	One lunar day (~14 Earth days)
2	Landing Site (Prime)	4 km x 2.4 km 69.367621 S, 32.348126 E
3	Science Payloads	1. Radio Anatomy of Moon Bound Hypersensitive ionosphere and Atmosphere (RAMBHA) 2. Chandra's Surface Thermo physical Experiment (ChaSTE) 3. Instrument for Lunar Seismic Activity (ILSA) 4. Laser Retroreflector Array (LRA) 5. Alpha Particle X-Ray Spectrometer (APXS) 6. Laser Induced Breakdown Spectroscope (LIBS) 7. Spectro-polarimetry of HAbitable Planet Earth (SHAPE)

Specifications for Chandrayaan-3

S/N	Parameter	Specifications
4	Two Module Configuration	1. Propulsion Module (Carries Lander from launch injection to Lunar orbit) 2. Lander Module (Rover is accommodated inside the Lander)
5	Mass	1. Propulsion Module: 2148 kg 2. Lander Module: 1752 kg including Rover of 26 kg 3. Total: 3900 kg
6	Power generation	1. Propulsion Module: 758 W 2. Lander Module: 738W, WS with Bias 3. Rover: 50W
7	Communication	1. Propulsion Module: Communicates with IDSN 2. Lander Module: Communicates with IDSN and Rover. Chandrayaan-2 Orbiter is also planned for contingency link. 3. Rover: Communicates only with Lander.

Specifications for Chandrayaan-3

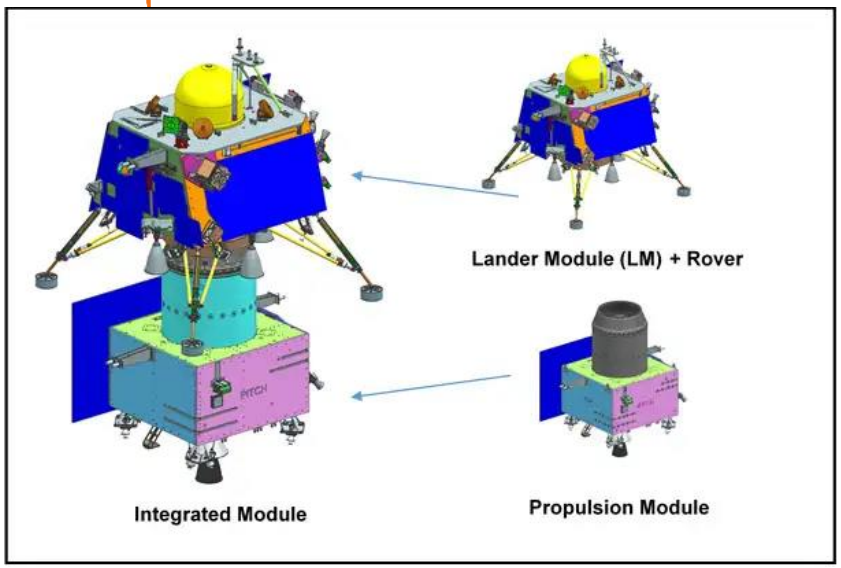
S/N	Parameter	Specifications
8	Lander Sensors	1. Laser Inertial Referencing and Accelerometer Package (LIRAP) 2. Ka-Band Altimeter (KaRA) 3. Lander Position Detection Camera (LPDC) 4. LHDAC (Lander Hazard Detection & Avoidance Camera) 5. Laser Altimeter (LASA) 6. Laser Doppler Velocimeter (LDV) 7. Lander Horizontal Velocity Camera (LHVC) 8. Micro Star sensor 9. Inclinometer & Touchdown sensors
9	Lander Actuators	Reaction wheels – 4 nos (10 Nms & 0.1 Nm)
10	Lander Propulsion System	1. Lander leg 2. Rover Ramp (Primary & Secondary) 3. Rover 4. ILSA, Rambha & Chaste Payloads 5. Umbilical connector Protection Mechanism, 6. X- Band Antenna

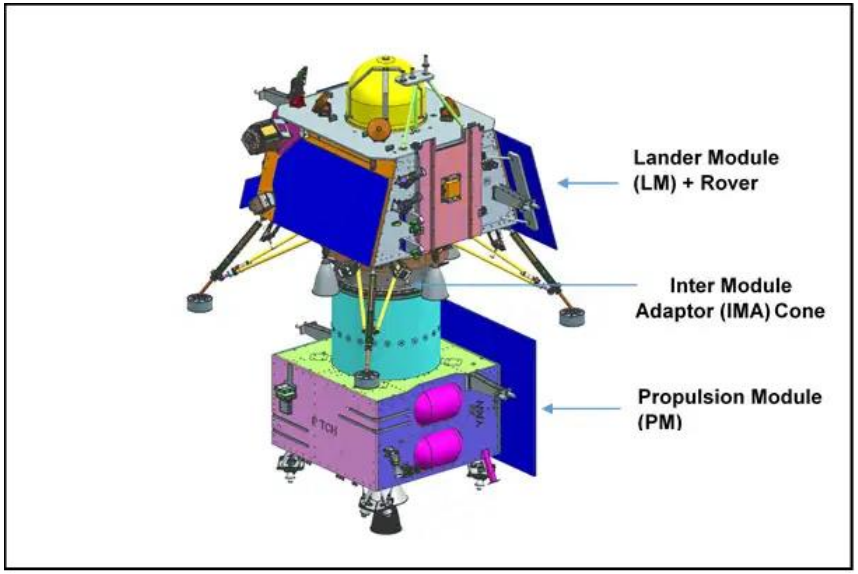
Specifications for Chandrayaan-3

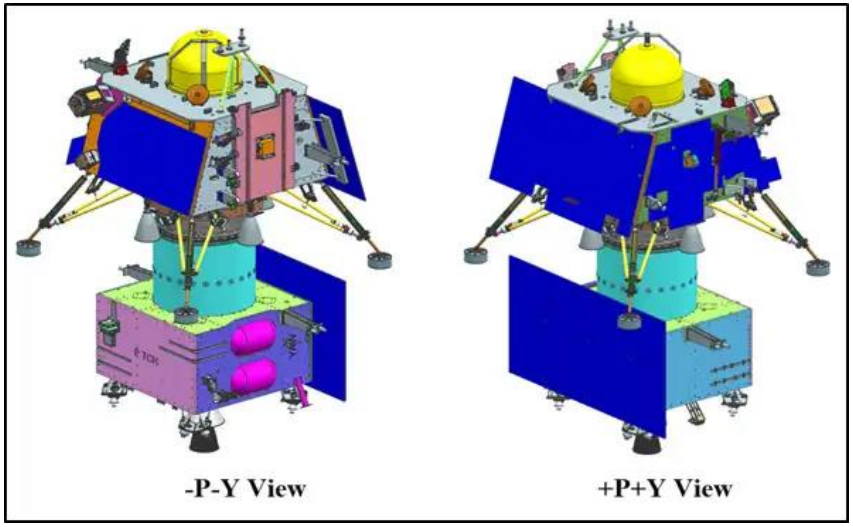
Lander Touchdown specifications

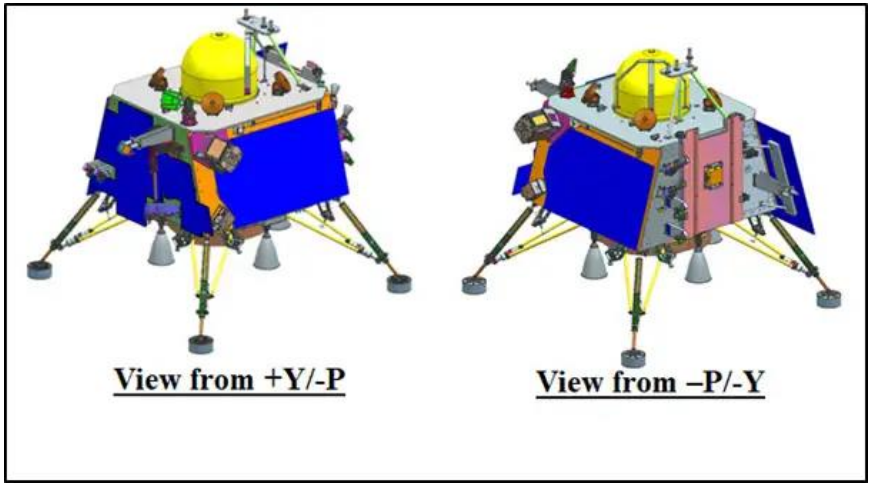
1. Vertical velocity: ≤ 2 m / sec
2. Horizontal velocity: ≤ 0.5 m / sec
3. Slope: ≤ 120

Three dimensional views of Chandrayaan-3 modules

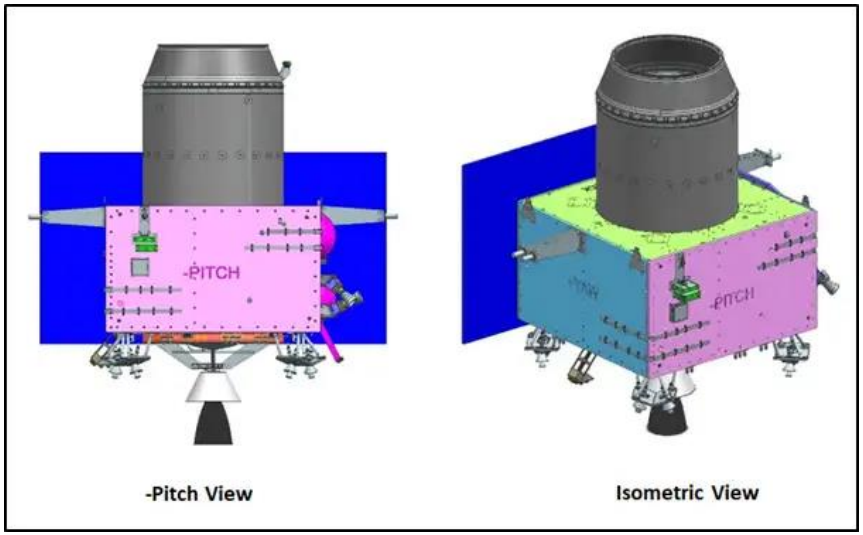


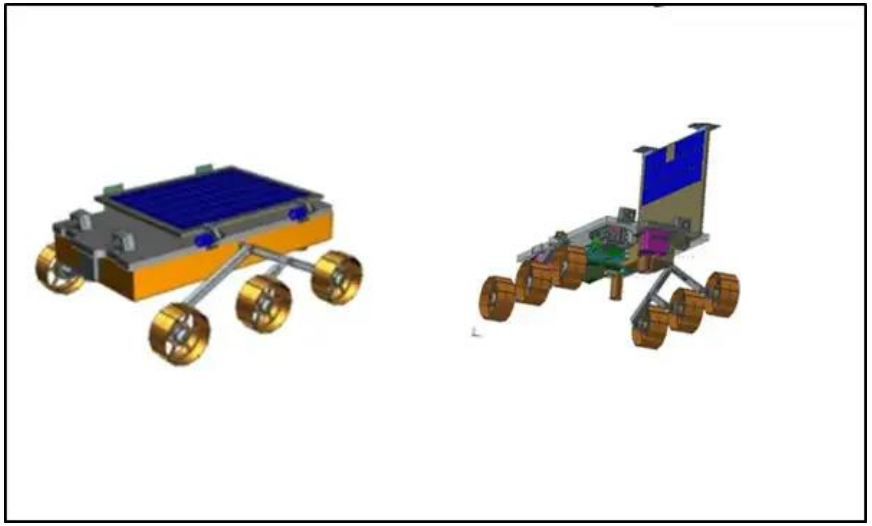


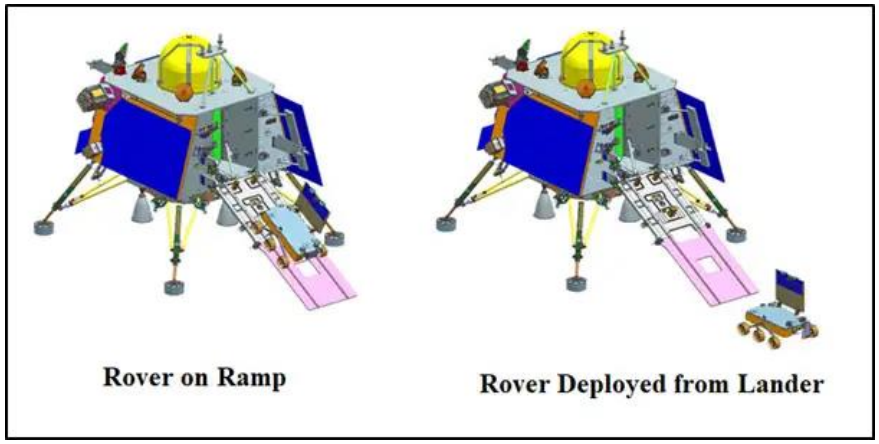




Three dimensional views of Chandrayaan-3 modules







Lander Payloads

RAMBHA-LP
Langmuir Probe

To measure the near surface plasma (ions and electrons) density and its changes with time.

ChaSTE
Chandra's Surface Thermo-physical Experiment

To carry out the measurements of thermal properties of lunar surface near polar region.

ILSA
Instrument for Lunar Seismic Activity

To measure seismicity around the landing site and delineating the structure of the lunar crust and mantle.

Rover Payloads

APXS
Alpha Particle X-Ray Spectrometer

To derive the chemical composition and infer mineralogical composition to further enhance our understanding of lunar surface.

LIBS
Laser Induced Breakdown Spectroscope

To determine the elemental composition (Mg, Al, Si, K, Ca,Ti, Fe) of lunar soil and rocks around the lunar landing site.

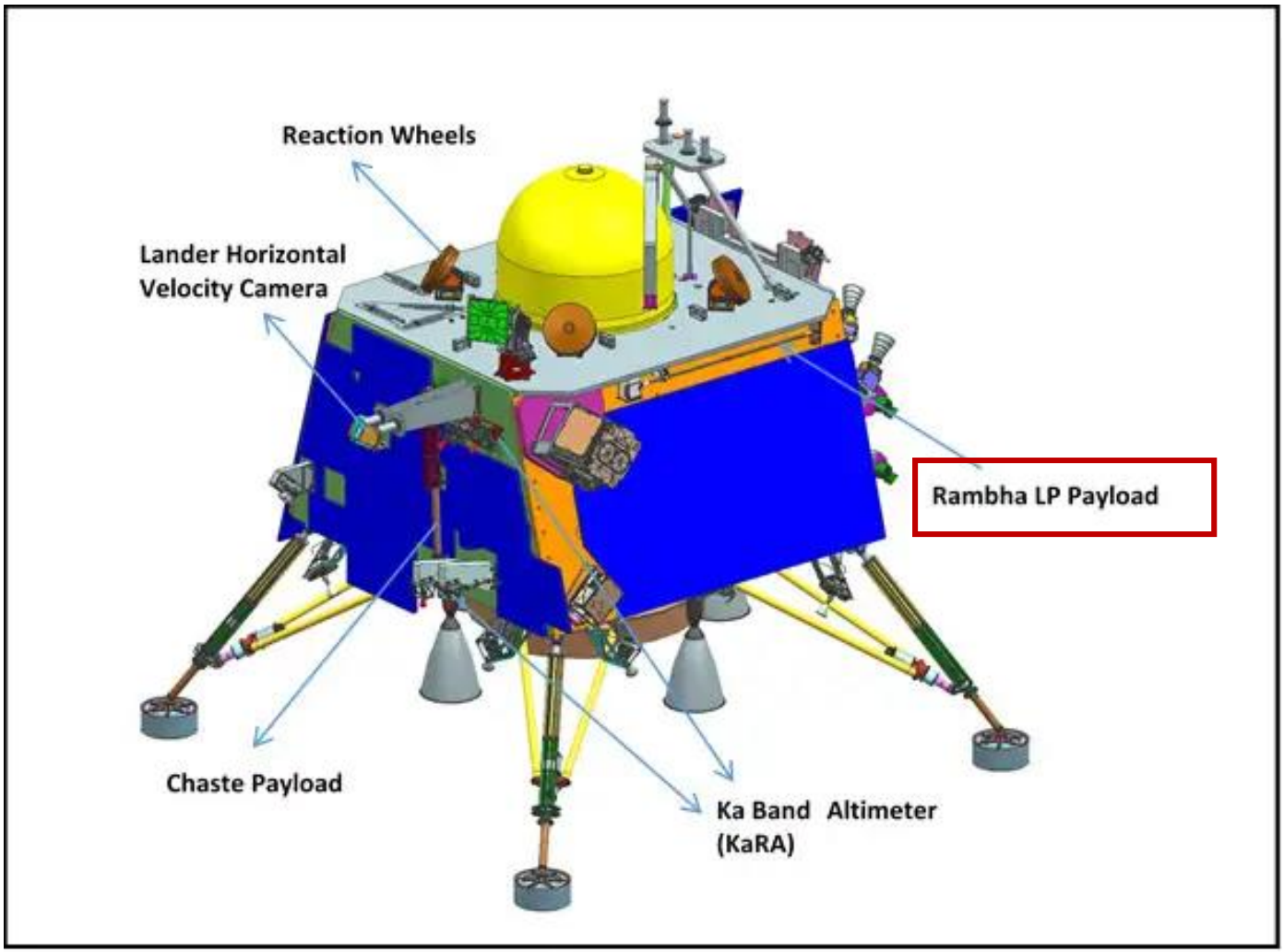
Propulsion Module Payload

SHAPE
Spectro-polarimetry of HAbitable Planet Earth

An experimental payload to study the spectro-polarimetric signatures of the habitable planet Earth in the near-infrared (NIR) wavelength range (1-1.7 μm).

Three dimensional views of Chandrayaan-3 modules

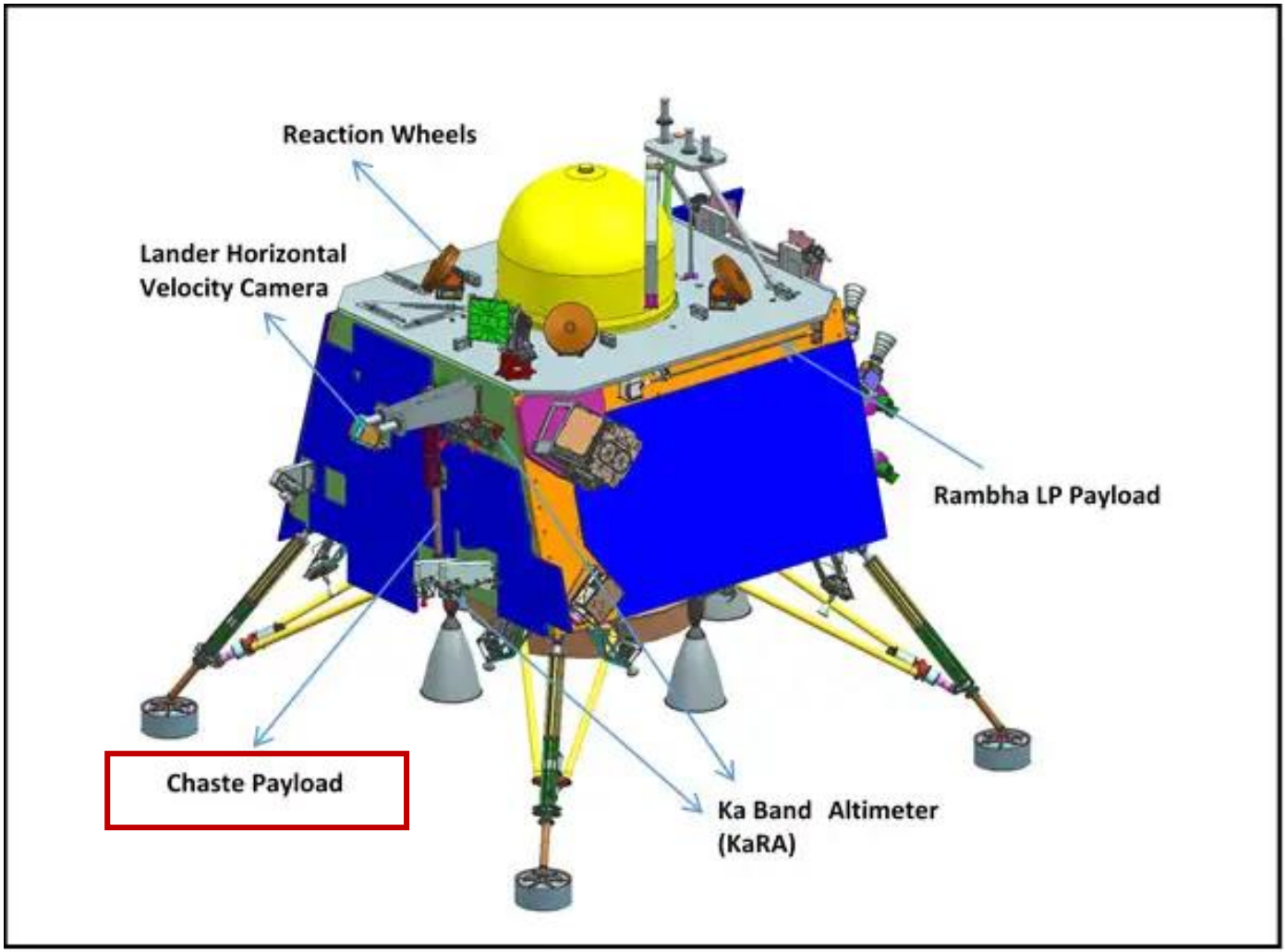
Radio Anatomy of Moon Bound Hypersensitive ionosphere and Atmosphere (RAMBHA)-Longmuir Probe



To measure the near surface plasma (ions and electrons) density and its changes with time

Three dimensional views of Chandrayaan-3 modules

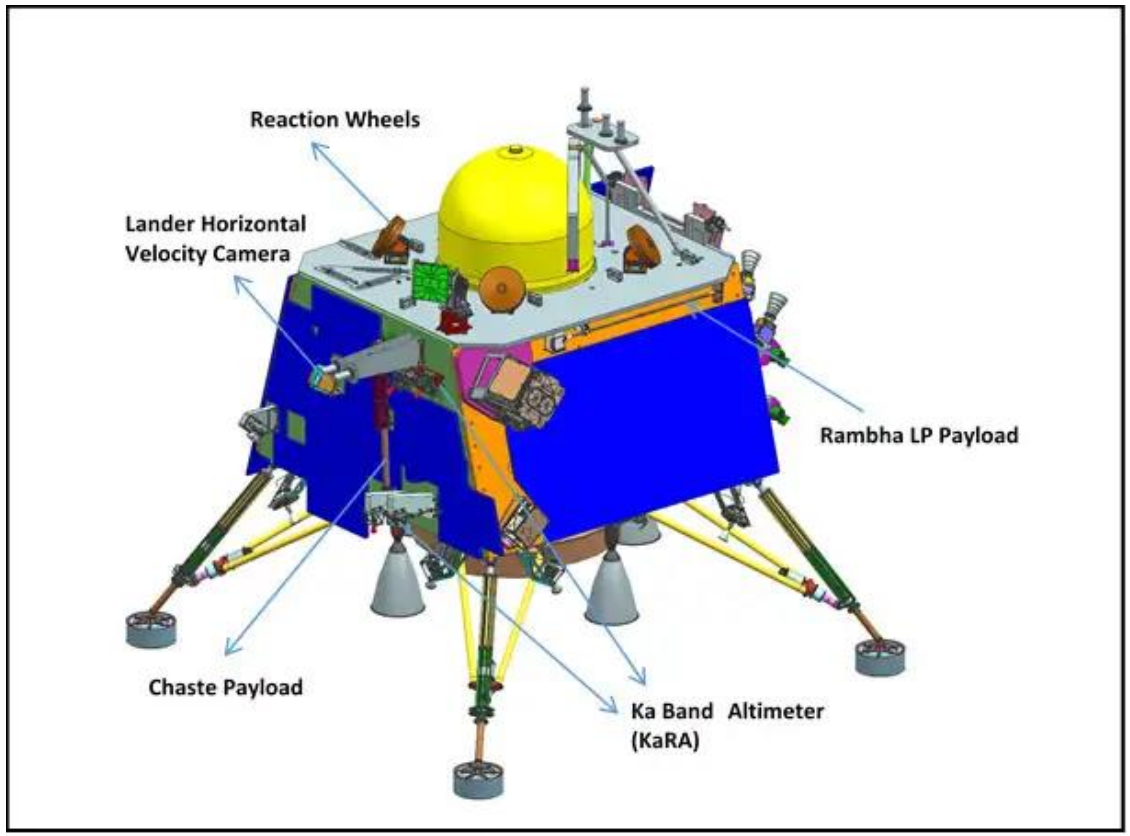
Chandra's Surface Thermo physical Experiment (ChaSTE)



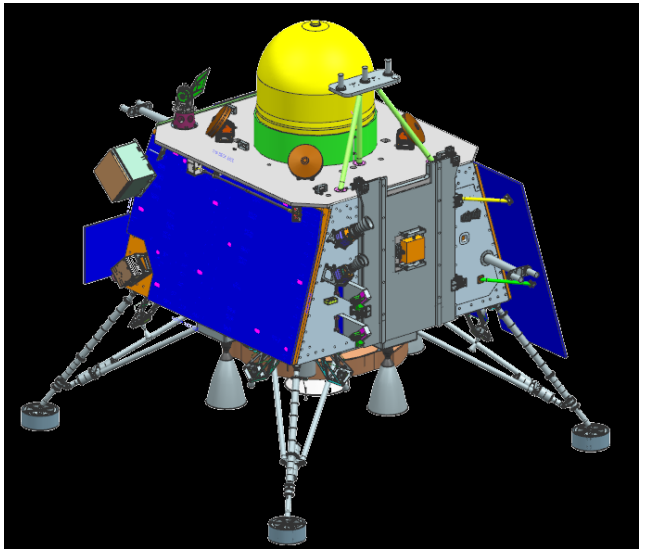
To carry out the measurements of thermal properties of lunar surface near polar region.

Three dimensional views of Chandrayaan-3 modules

Instrument for Lunar Seismic Activity (ILSA)

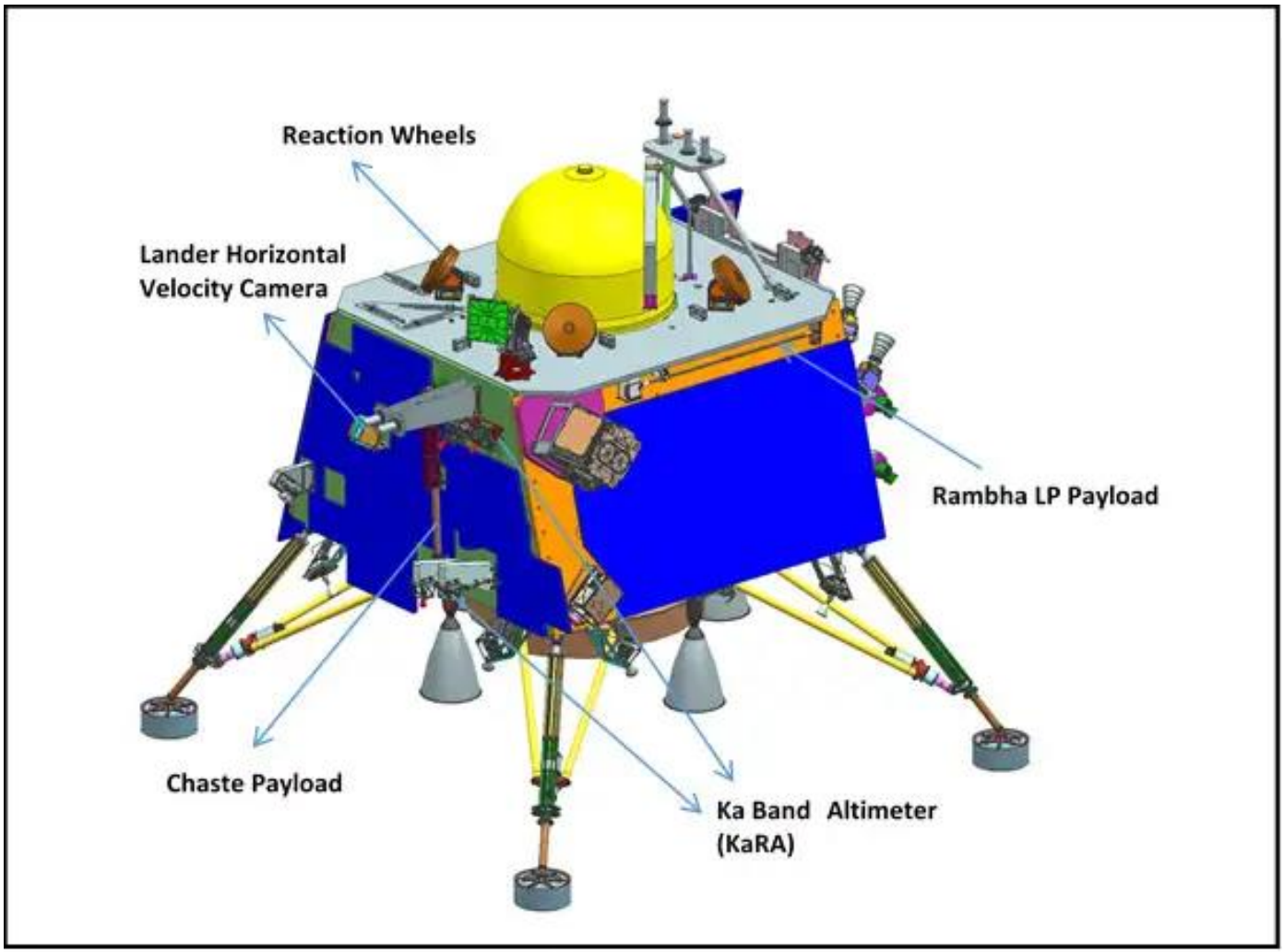


To measure seismicity around the landing site and delineating the structure of the lunar crust and mantle.



Three dimensional views of Chandrayaan-3 modules

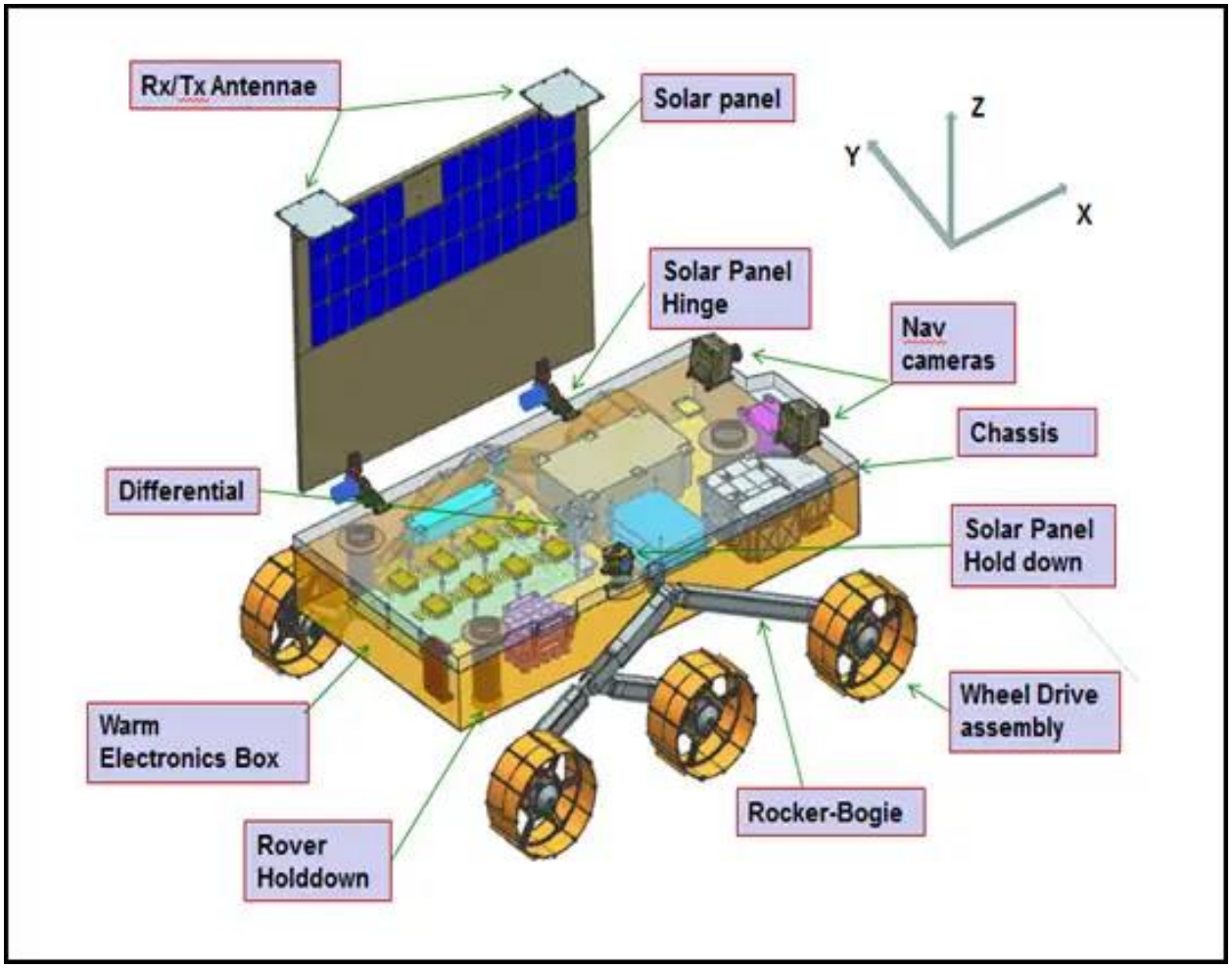
LASER Retroreflector Array (LRA)



It is a passive experiment to understand the dynamics of Moon system.

Three dimensional views of Chandrayaan-3 modules

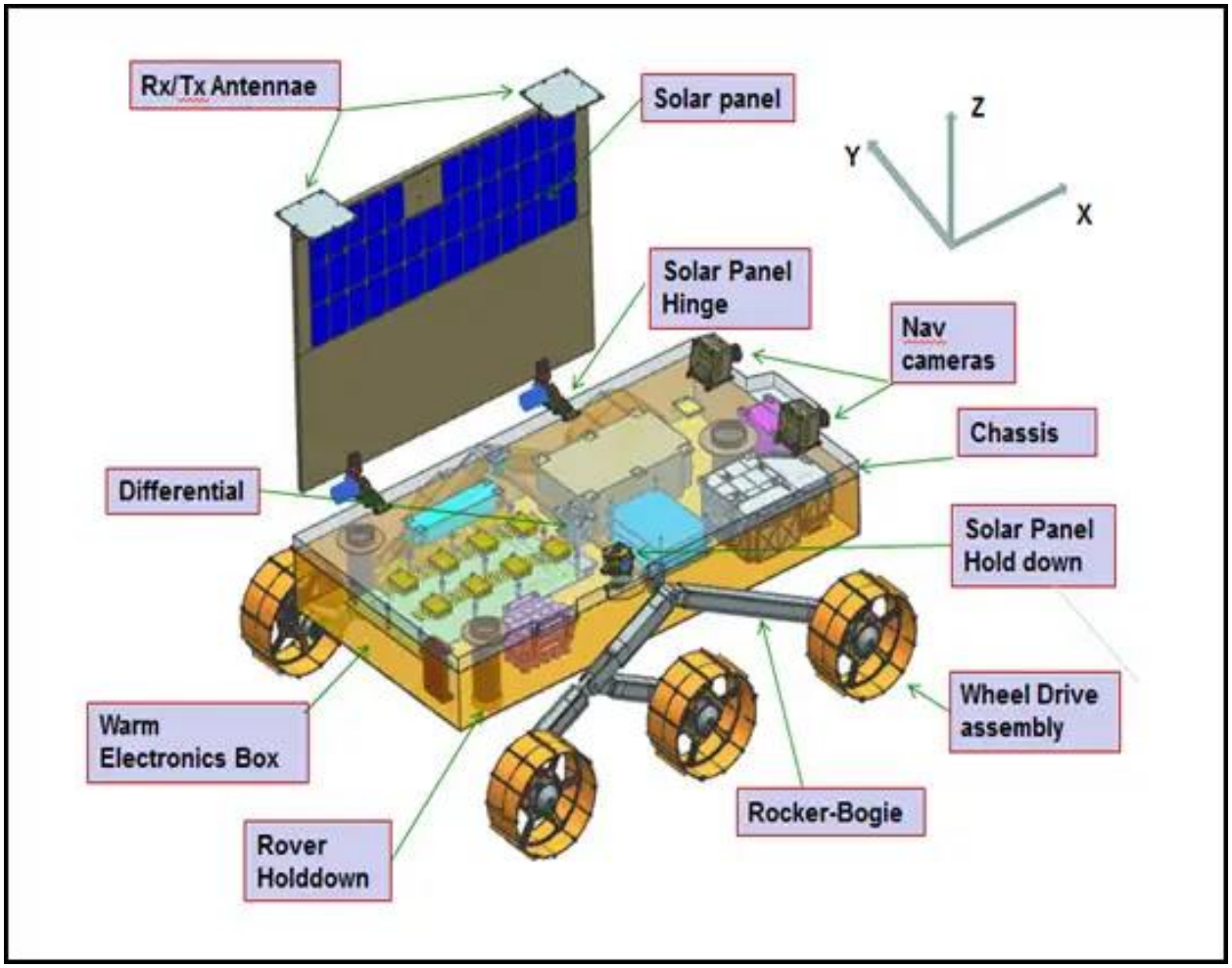
LASER Induced Breakdown Spectroscope (LIBS)



Qualitative and quantitative elemental analysis & To derive the chemical Composition and infer mineralogical composition to further our understanding of Lunar-surface.

Three dimensional views of Chandrayaan-3 modules

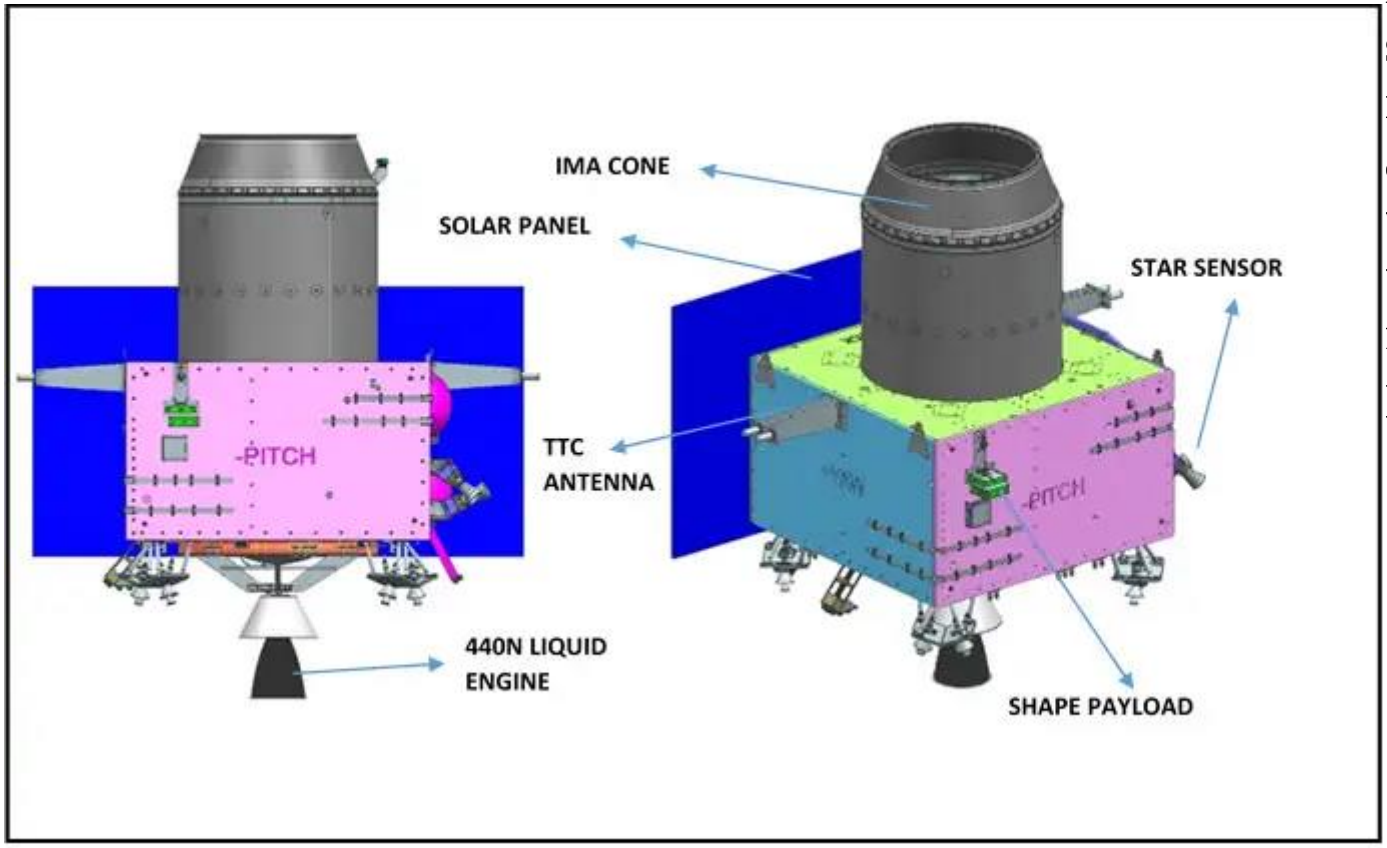
Alpha Particle X-ray Spectrometer (APXS)



To determine the elemental composition (Mg, Al, Si, K, Ca,Ti, Fe) of Lunar soil and rocks around the lunar landing site.

Three dimensional views of Chandrayaan-3 modules

Spectro-polarimetry of HAbitable Planet Earth (SHAPE)



Future discoveries of smaller planets in reflected light would allow us to probe into variety of Exo-planets which would qualify for habitability (or for presence of life).

How To reach Moon and Land On the Surface of the Moon

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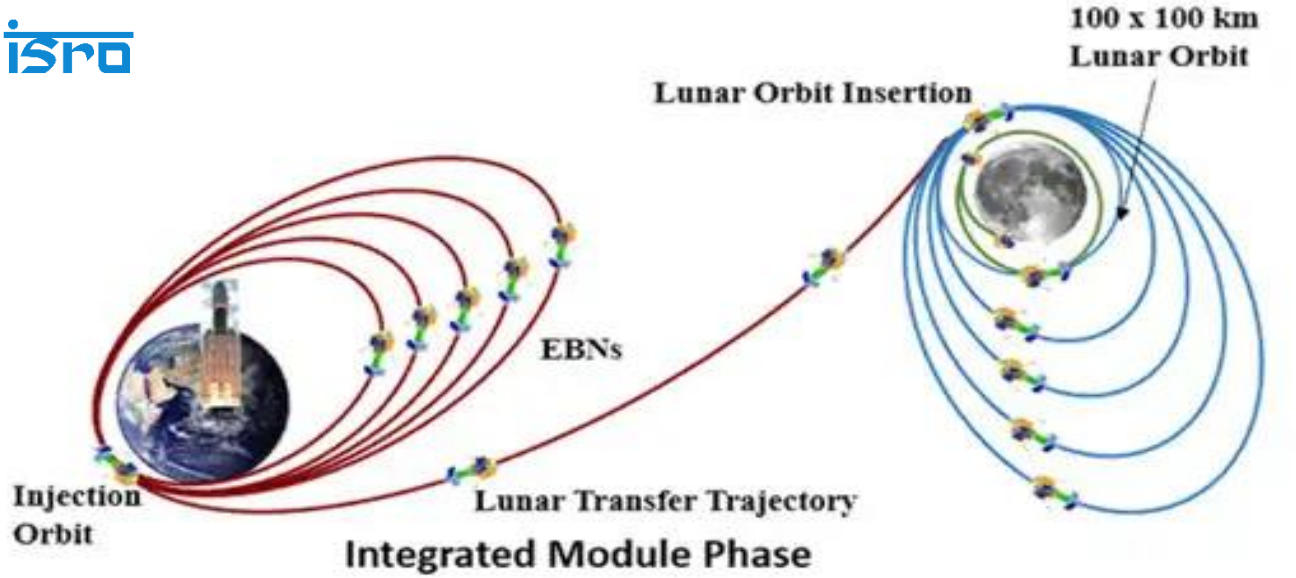
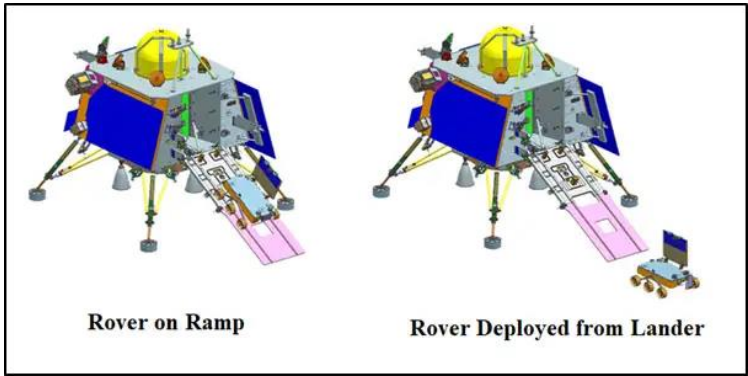
LVM3-M4/ Chandrayaan-3 Mission

Chandrayaan-3, India's third lunar exploration mission is ready to take off in fourth operational mission (M4) of LVM3 launcher. ISRO is crossing new frontiers by demonstrating soft landing on lunar surface by its lunar module and demonstrate roving on the lunar terrain. It is expected to be supportive to ISRO's future interplanetary missions.

Additionally the deployment of rover and in-situ scientific experiment will scale new heights in lunar expeditions by deploying Rover. Yes, ISRO is bringing the Moon closer to us.

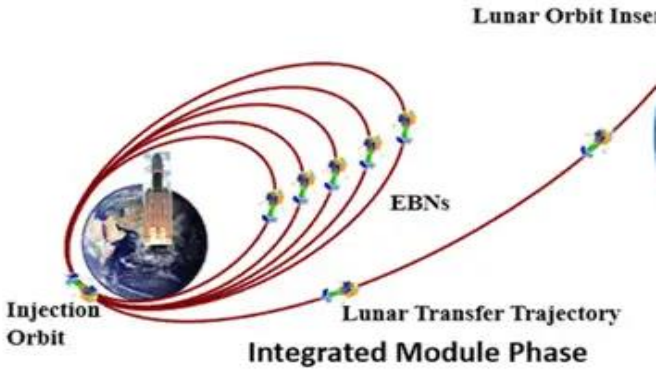
How To reach Moon and Land On the Surface of the Moon





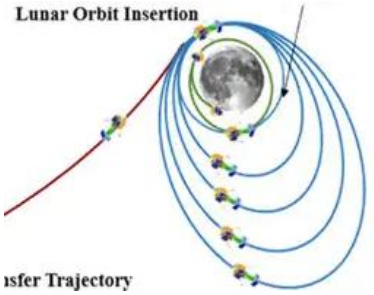
The various Mission phases

1. ***Earth Centric Phase (Phase-1)***
- Pre-Launch Phase
- Launch and Ascent Phase
- Earth-bound Manoeuvre Phase



2. ***Lunar Transfer phase (Phase-2)***
- Transfer Trajectory Phase

3. Moon centric phase
- Lunar Orbit Insertion Phase (LOI)-(Phase-3)
- Moon-bound Manoeuvre Phase (Phase-4)
- Propulsion Module and Lander Separation (Phase-5)
- De-boost Phase (Phase-6)
- Pre-Landing Phase (Phase-7)
- ***Landing Phase for Lander (Phase-8)***
- ***Normal Phase for Lander and Rover-Rover (Phase-9)***
- ***Moon-Centric Normal Orbit Phase (100x100 km Orbit) -For Propulsion Module-(Phase-10)***



Mission sequence

The various mission phases are classified as follows:

1. Earth Centric Phase (Phase-I)

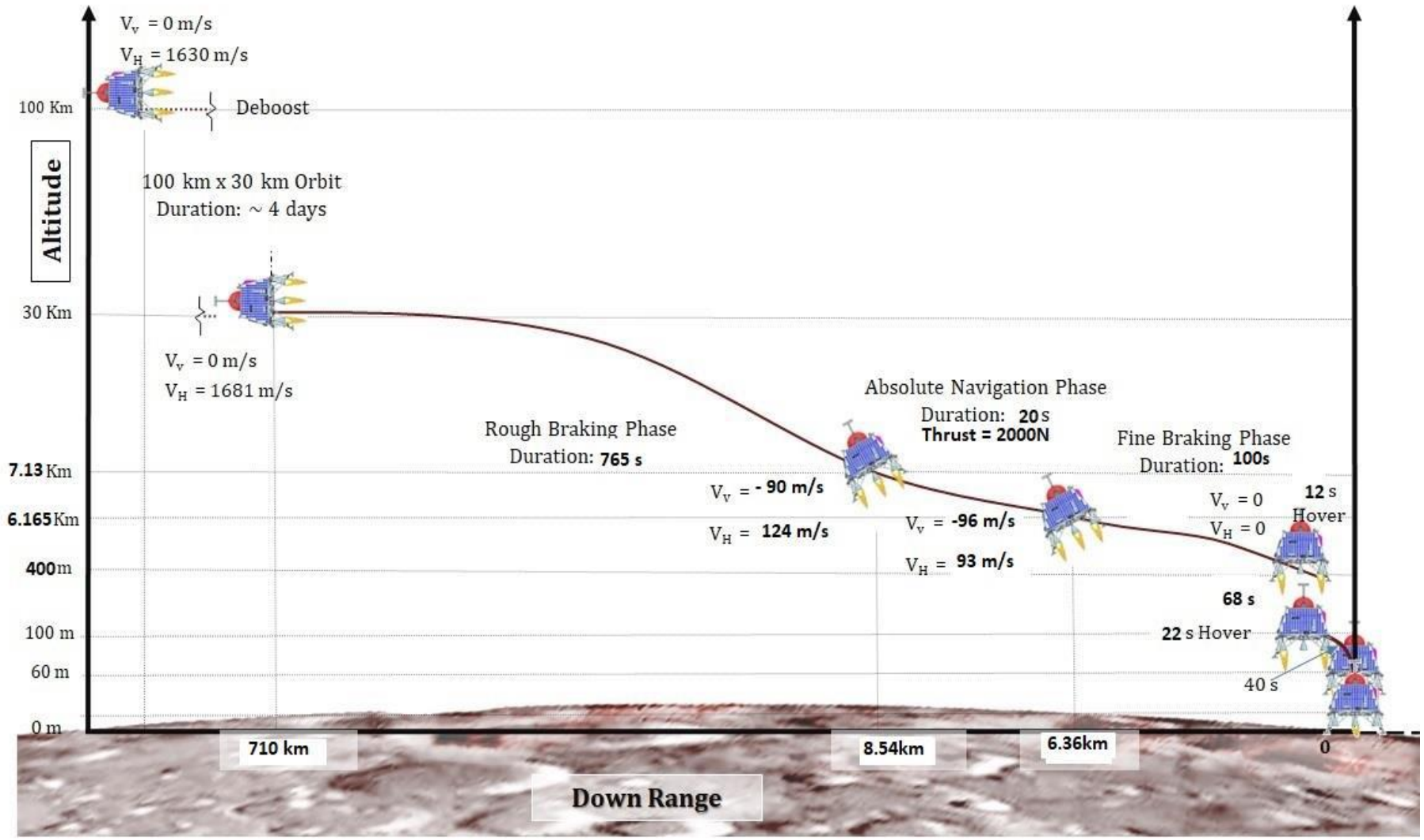
- Pre-launch Phase
- Launch and Ascent Phase
- Earth-bound Manoeuvre Phase

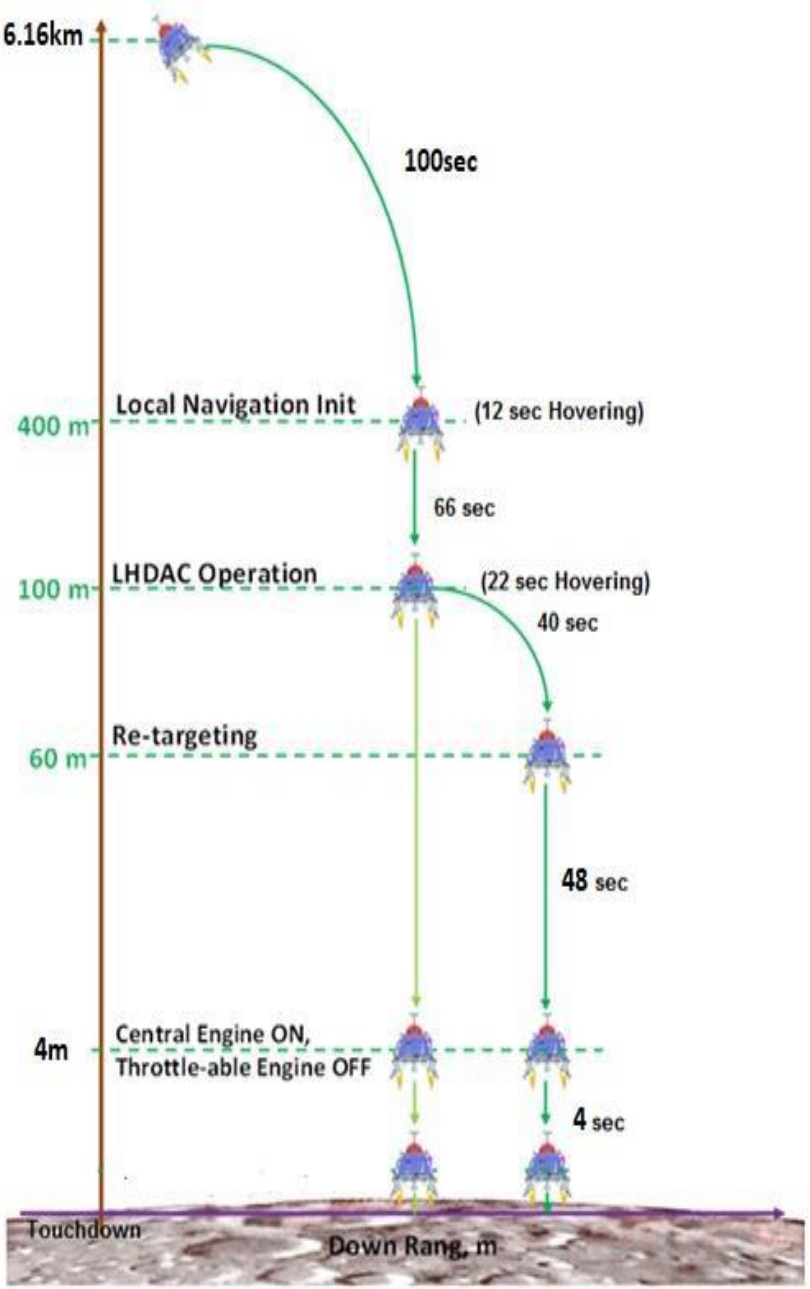
2. Lunar Transfer Phase (Phase-2)

- Transfer Trajectory Phase

3. Moon Centric Phase

- Lunar Orbit Insertion Phase (LOI)-(Phase-3)
- Moon-bound Manoeuvre Phase (Phase-4)
- PM and Lunar Module Separation (Phase-5)
- De-boost Phase (Phase-6)
- Pre-landing Phase (Phase-7)
- Landing Phase (Phase-8)
- Normal Phase for Lander and Rover (Phase-9)
- Moon Centric Normal Orbit Phase (100 km circular orbit) - For Propulsion Module (Phase-10)


V_v = 0 m/s
V_H = 1630 m/s
100 Km
Deboost
Altitude
100 km x 30 km Orbit
Duration: ~ 4 days
30 Km
V_v = 0 m/s
V_H = 1681 m/s
Rough Braking Phase
Duration: 765 s
Absolute Navigation Phase
Duration: 20 s
Thrust = 2000N
Fine Braking Phase
Duration: 100s
7.13 Km
6.165 Km
400 m
100 m
60 m
0 m
V_v = - 90 m/s
V_H = 124 m/s
V_v = -96 m/s
V_H = 93 m/s
V_v = 0
V_H = 0
12 s
Hover
68 s
22 s Hover
40 s
710 km
8.54km
6.36km
0
Down Range


6.16km
100sec
400 m
Local Navigation Init
(12 sec Hovering)
66 sec
100 m
LHDAC Operation
(22 sec Hovering)
40 sec
60 m
Re-targeting
48 sec
4m
Central Engine ON,
Throttle-able Engine OFF
4 sec
Touchdown
Down Rang, m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TAVD/URSC


VIBRATION TEST FACILITY


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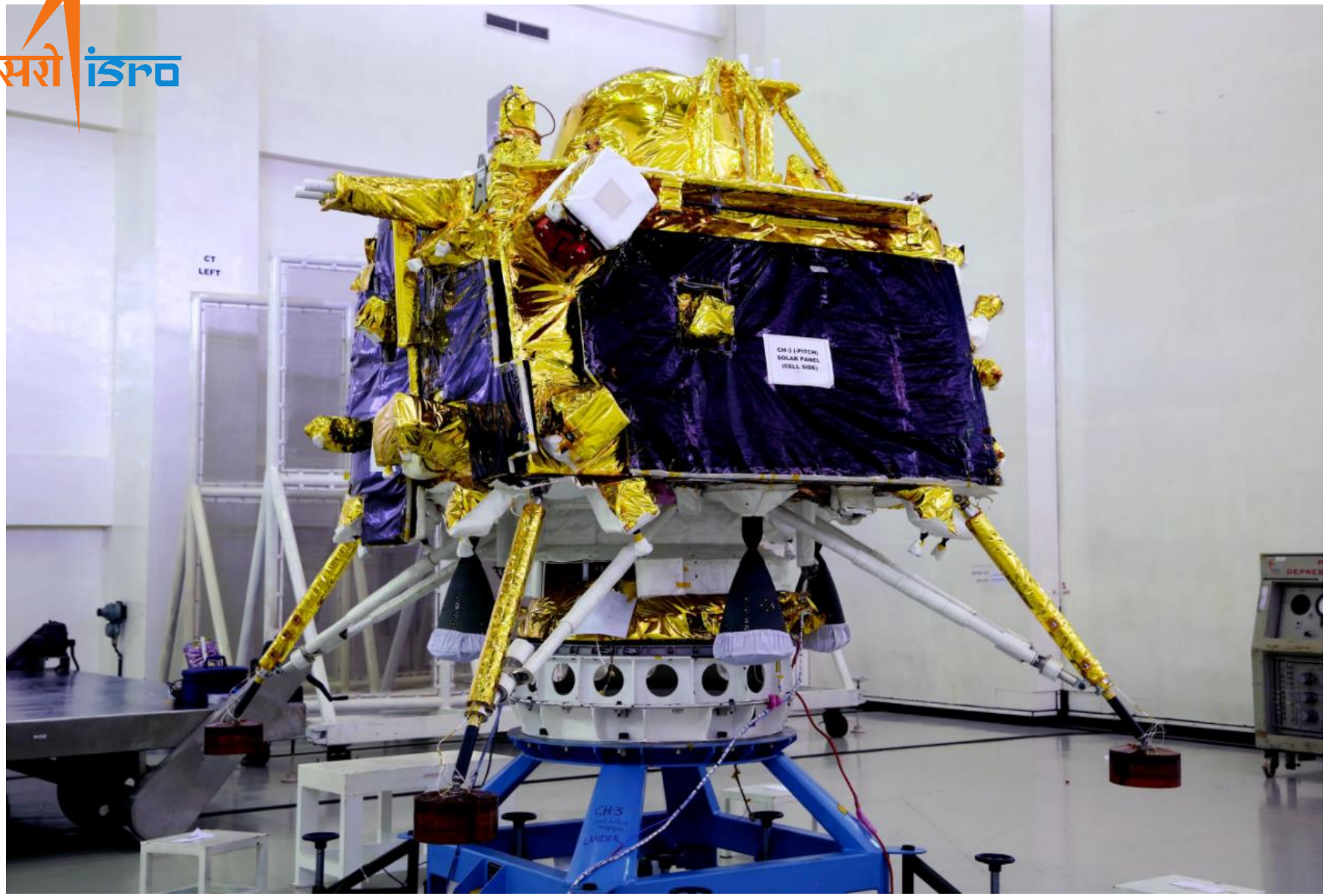
TAVD/URSC


INDIA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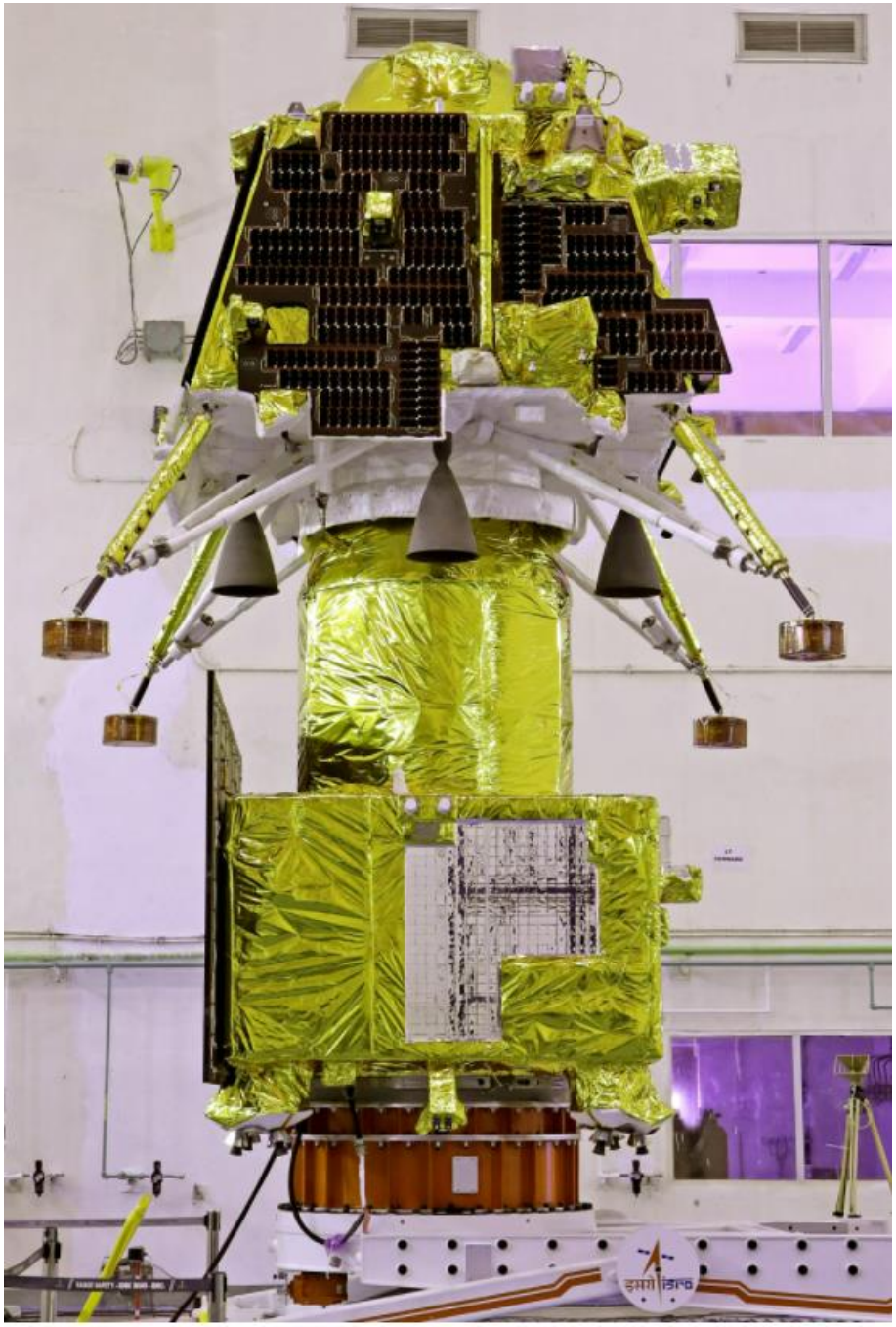
CT
LEFT
CH-3 (-PITCH)
SOLAR PANEL
(CELL SIDE)
CH-3
LANDER



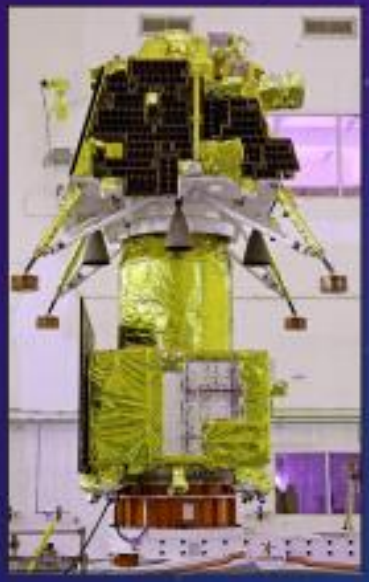
LVM3-M4 Mission

LVM3-M4 heat shield closing activity

LVM3-M4 Mission

Chairman, ISRO visited to SP2B, SVAB & TCX-2 Facilities on 21-06-2023

Integration Activities of LVM3-M4

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ISRO
एलवीएम 3
एम4
भारत
INDIA


PM
S200
PM

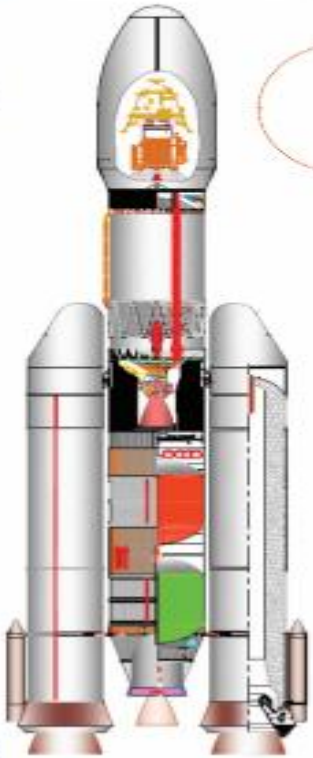
LVM3-M4/ Chandrayaan-3 Mission

LVM3 is the operational heavy lift launch vehicle of ISRO and has a spectacular pedigree of completing 6 consecutive successful missions. This is the 4th operational flight of LVM3, aims to launch the Chandrayaan-3 spacecraft to Geo Transfer Orbit (GTO).

LVM3 has proved its versatility to undertake most complex missions like:

- Injecting multi-satellites
- Mission planning to ensure safe relative distance among separated satellites through re-orientation and velocity addition maneuvers.
- Multi orbit (LEO, MEO, GEO) and execute interplanetary missions.
- India's largest and heaviest launch vehicle ferrying indian and international customer satellites.

LVM3-M4 will be launched from the Second Launch Pad (SLP), SDSC, SHAR.



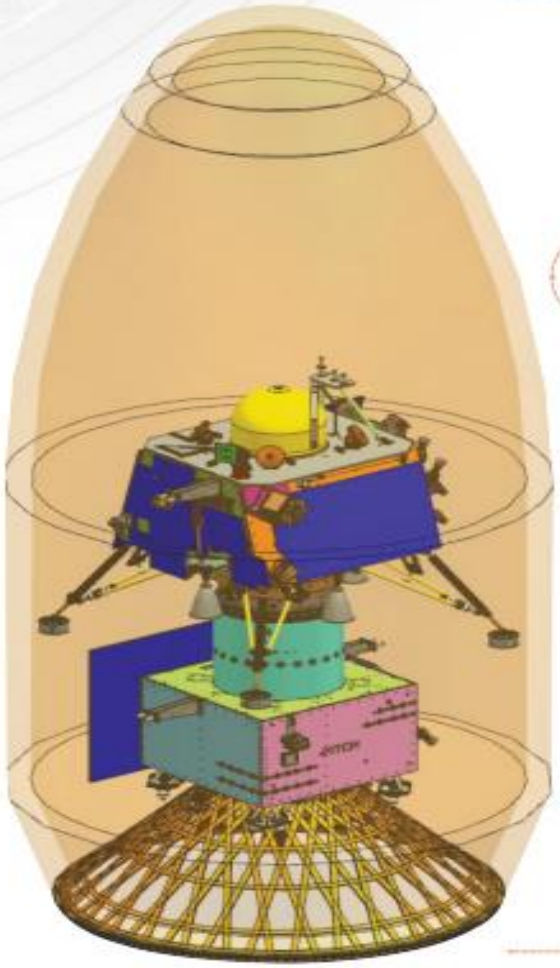
LVM3-M4 Vehicle Configuration (2S200+L110+C25+PLF)

Payload Mass: 3895 kg

LVM3-M4 Vehicle Characteristics

Height	43.5 m
Lift-off Mass	642 t
Propulsion Stages	
Strap-on Motors	2 x S200 (Solid)
Core Stage	L110 (Liquid)
Upper Stage	C25 (Cryo)
Payload Fairing	5 m OPLF

Payload Accommodation

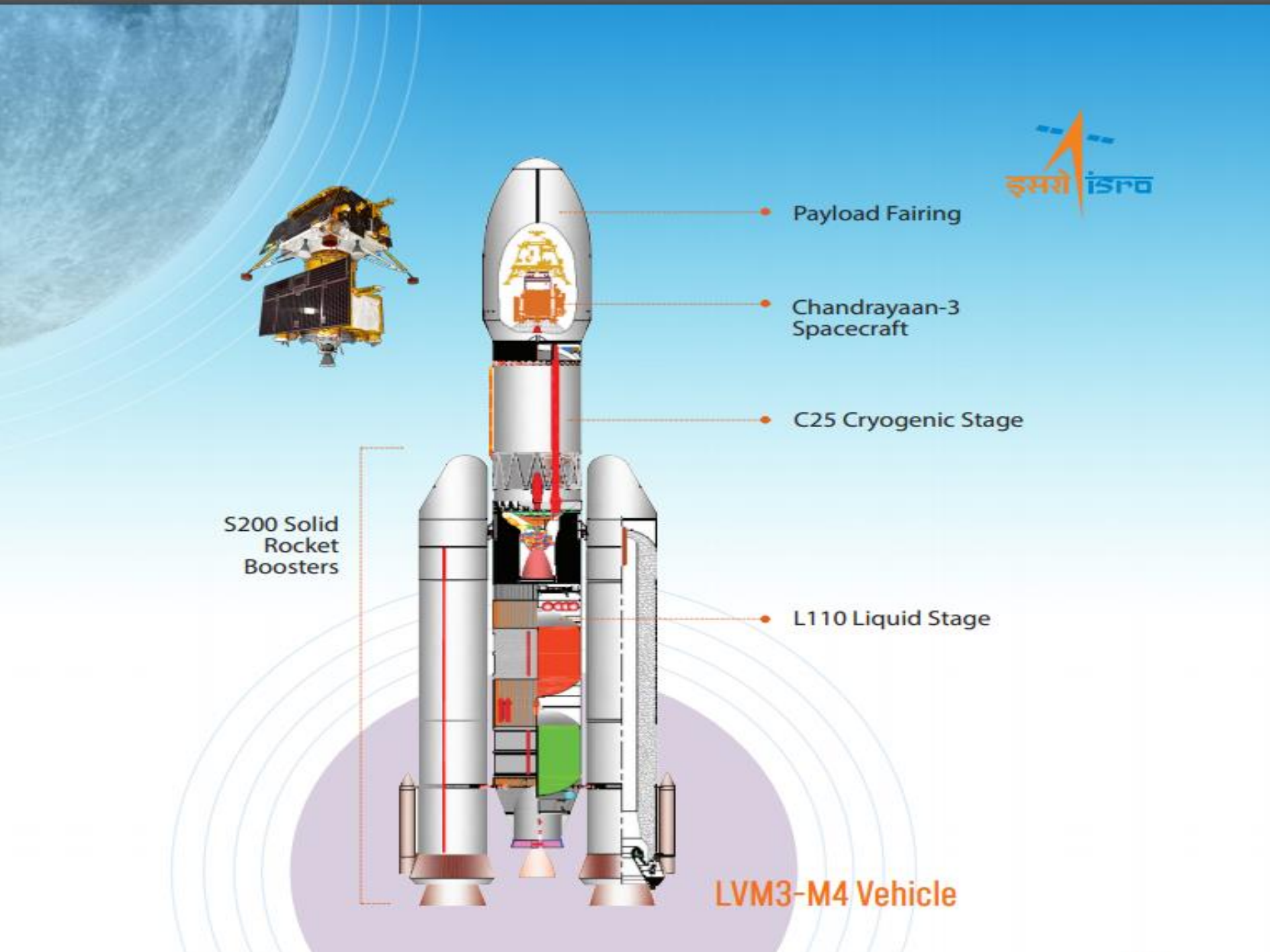


LVM3-M4 Mission Specifications

GTO Apogee	36500 ± 500 km
GTO Perigee	170 ± 3.5 km
Inclination	21.3°
Argument of Perigee	178 ± 0.2°
Launch Pad	SLP
Launch Azimuth	107°

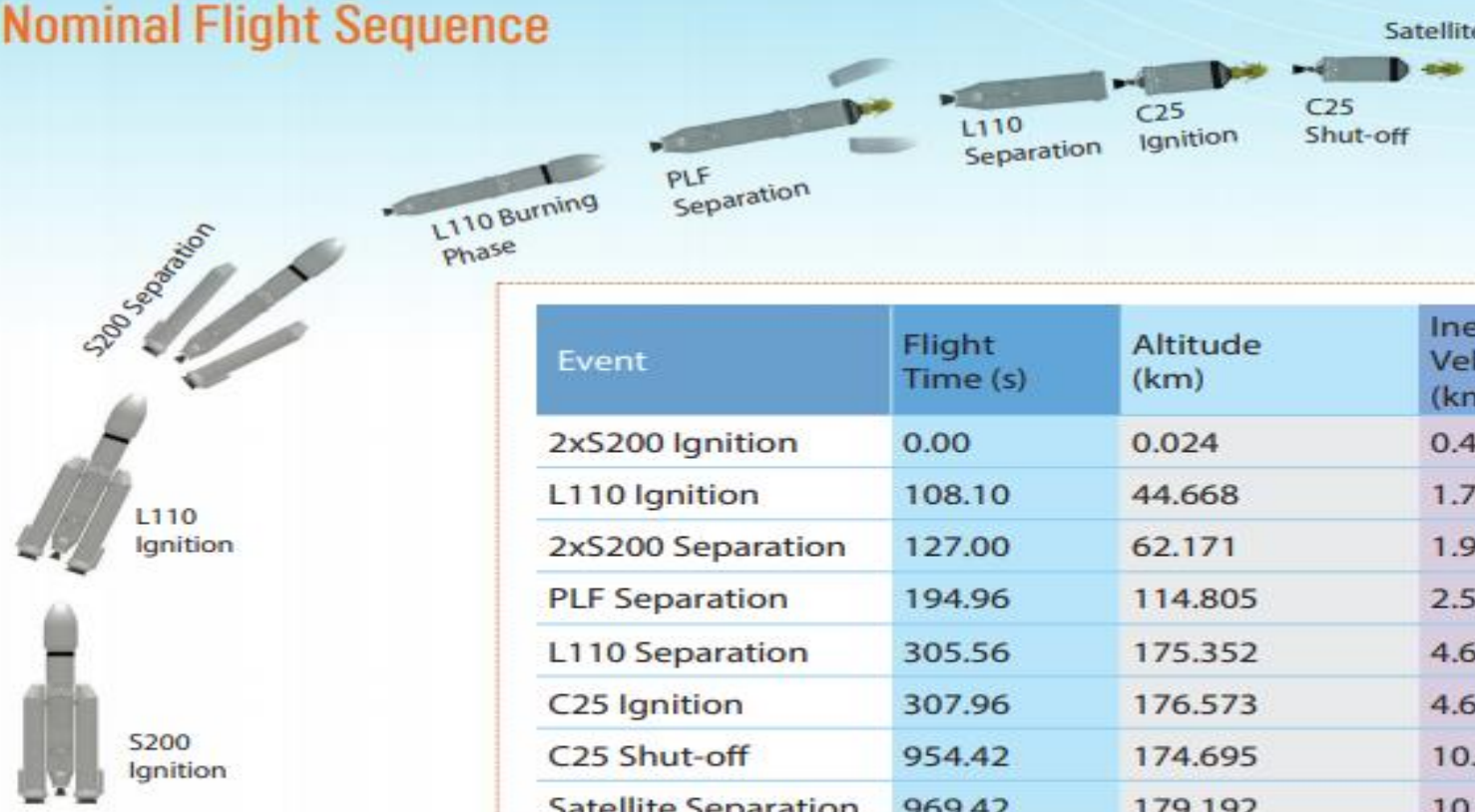
LVM3-M4 Stages at a Glance

Stages	**Strap-Ons (2 x S200)**	**Core Stage (L110)**	**Upper Stage (C25)**
Length (m)	26.22	21.4	13.5
Diameter (m)	3.2	4.0	4.0
Propellant Type	Solid (HTPB)	Liquid ($UH25 + N_2O_4$)	Cryo (LH_2 & LOX)
Propellant Mass (t)	204.5 (each)	115.8	28.6


Payload Fairing
Chandrayaan-3 Spacecraft
C25 Cryogenic Stage
S200 Solid Rocket Boosters
L110 Liquid Stage
LVM3-M4 Vehicle

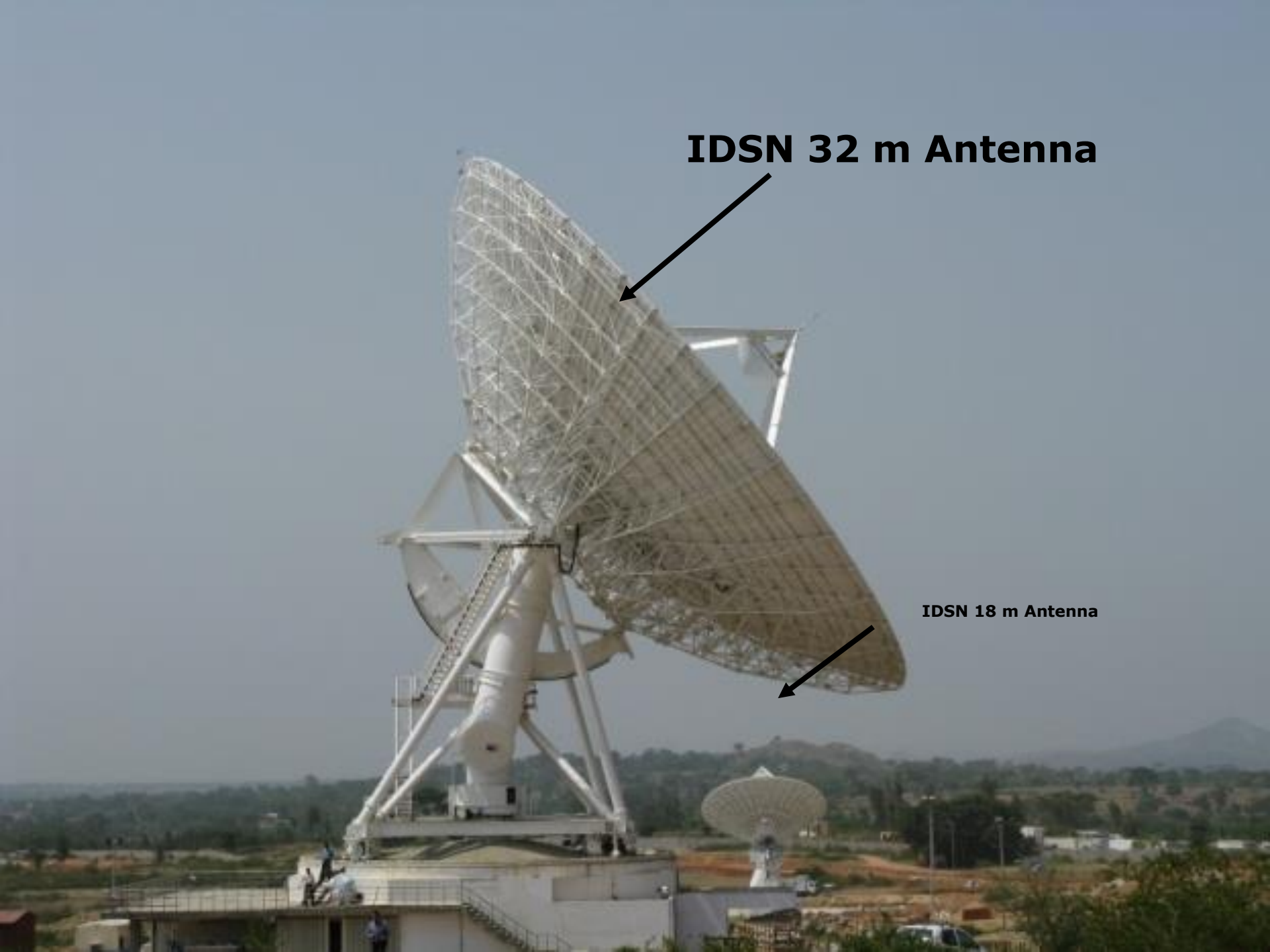
LVM3-M4/ Chandrayaan-3 Mission

Nominal Flight Sequence



Event	Flight Time (s)	Altitude (km)	Inertial Velocity (km/s)
2xS200 Ignition	0.00	0.024	0.452
L110 Ignition	108.10	44.668	1.788
2xS200 Separation	127.00	62.171	1.969
PLF Separation	194.96	114.805	2.560
L110 Separation	305.56	175.352	4.623
C25 Ignition	307.96	176.573	4.621
C25 Shut-off	954.42	174.695	10.242
Satellite Separation	969.42	179.192	10.269

Indian Deep Space Network


IDSN 32 m Antenna
IDSN 18 m Antenna

Luna 25
The Russian Lander to Moon

Ref: https://nssdc.gsfc.nasa.gov/nmc/spacecraft/display.action?id=LUNA-25
https://www.space.com/russia-luna-25-moon-lander-launch-delay-august-2023

Luna 25

- Luna 25, also designated the Luna-Glob-Lander
- Russian lunar lander mission currently scheduled for launch in August 2023
- It is targeted to the south polar region of the Moon.

scientific objectives of the mission:

- To study composition of the polar regolith,
- To study the plasma and dust components of the lunar polar exosphere.

Soyuz-2.1b

Dry mass is about 800 kg, and it is expected to have roughly **950 kg of propellant** at launch.

Luna 25

Lunar Robotic Arm

The LRA is equipped with a scoop (175 cubic cm volume) and a sample acquisition tool, a 4.7 cm long tube with an internal diameter of 1.25 cm.

The arm has four degrees of freedom / rotations: azimuthal, shoulder, elbow, and wrist/scoop.

Total mass of the LRA is 5.5 kg, it uses 30 W nominal, and 50 W maximum power.

The lander has a 1.6 meter-lomg (LRA, of Lunar Manipulator Complex) to remove and collect the surface regolith to depths of 25 cm.

Luna 25

POCKOCMOC

science instruments

Data transmission rates back to Earth are planned to be 4 Mbits/sec.

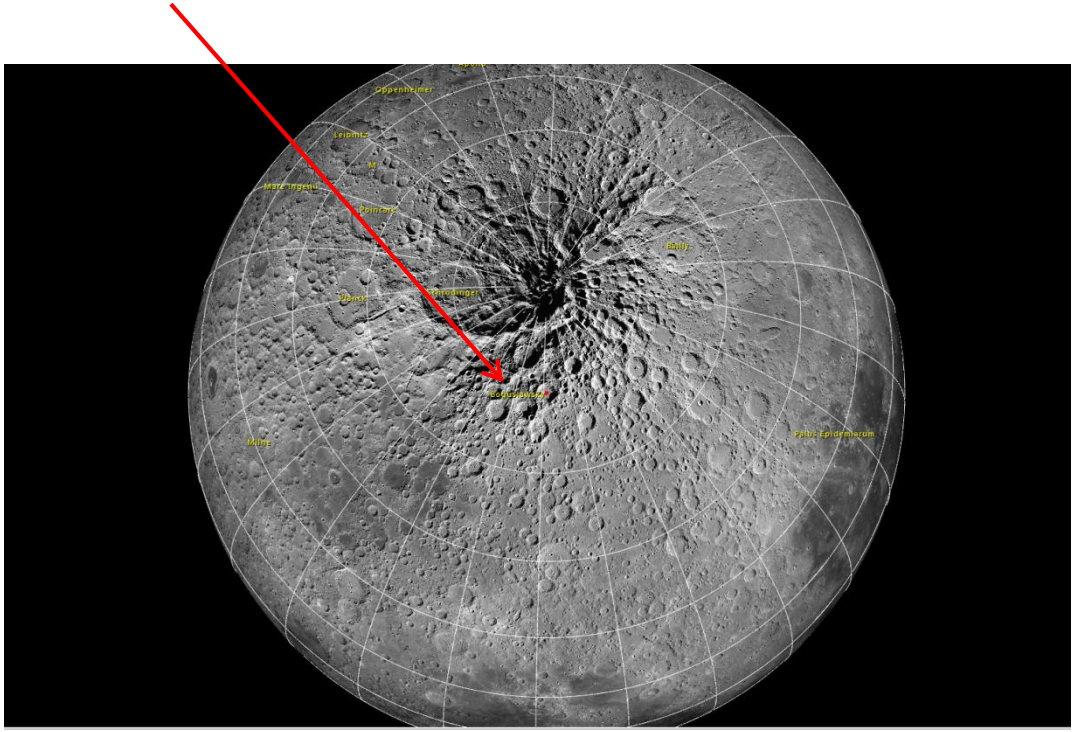
1. **ADRON-LR** is a gamma-ray and neutron spectrometer to study the surface regolith.
2. **ARIES-L** detects charged particles and neutrals in the polar exosphere.
3. **LIS-TV-RPM,** an infra-red spectrometer, measures surface water and OH and is mounted on the LRA.
4. The **LASMA-LR** mass spectrometer will measure composition of regolith samples (1 - 2 cubic cm) from the LRA using laser ablation.
5. The **PML** detector will study dust in the polar exosphere.
6. **STS-L** is a panoramic and local imaging system.

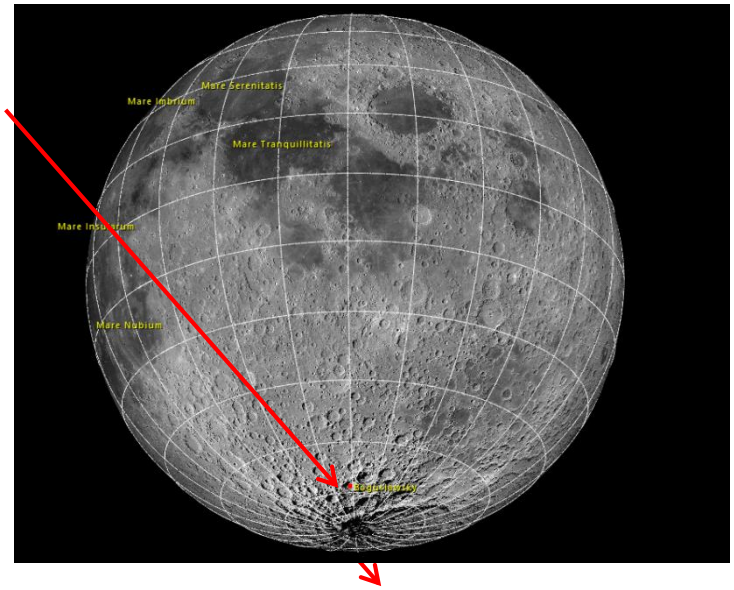
Luna 25

- Launch will be on a Soyuz-2 Fregat into Earth orbit.
- It will fire the Fregat again to go into a lunar transfer orbit and from lunar orbit it will drop down to the surface.
- Landing will be in the region of the lunar south pole, the main landing site is at **69.545 S, 43.544 E**, north of Boguslavsky crater. (Ch3:**69.367621 S, 32.348126 E**)
- The reserve landing site is at 68.773 S and 21.21 E, southwest of Manzini crater.
- Both coordinate points are centers of 15 x 30 km landing ellipses. The lander is expected to operate on the lunar surface, studying surface regolith and exospheric dust and particles, for one year.

Luna 25

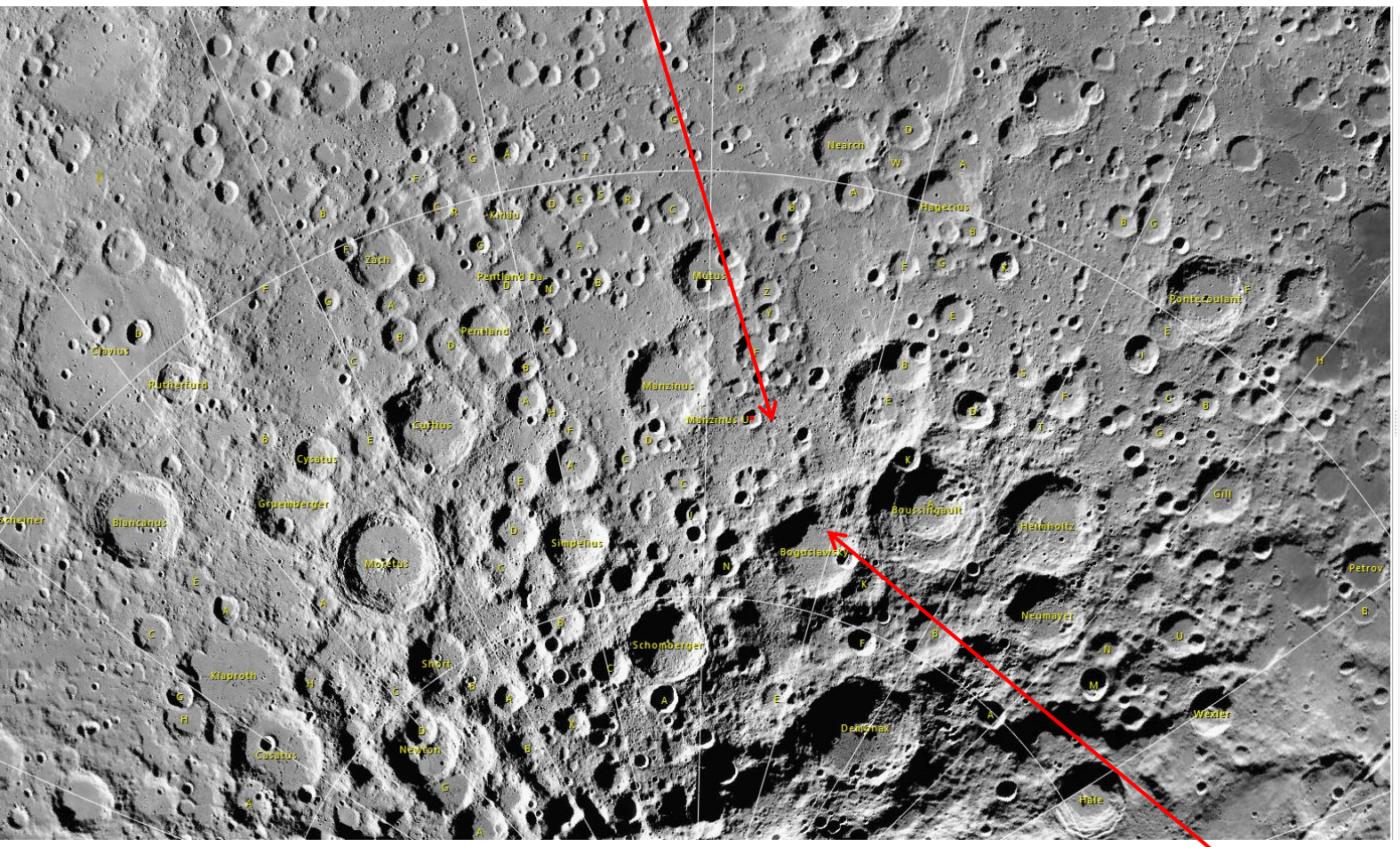
- Landing will be in the region of the lunar south pole, the main landing site is at **69.545 S, 43.544 E**, north of Boguslavsky crater. (Ch3:**69.367621 S, 32.348126 E**)

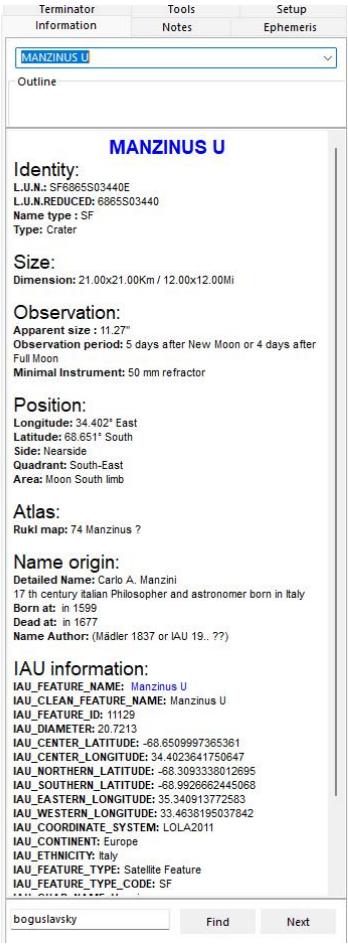




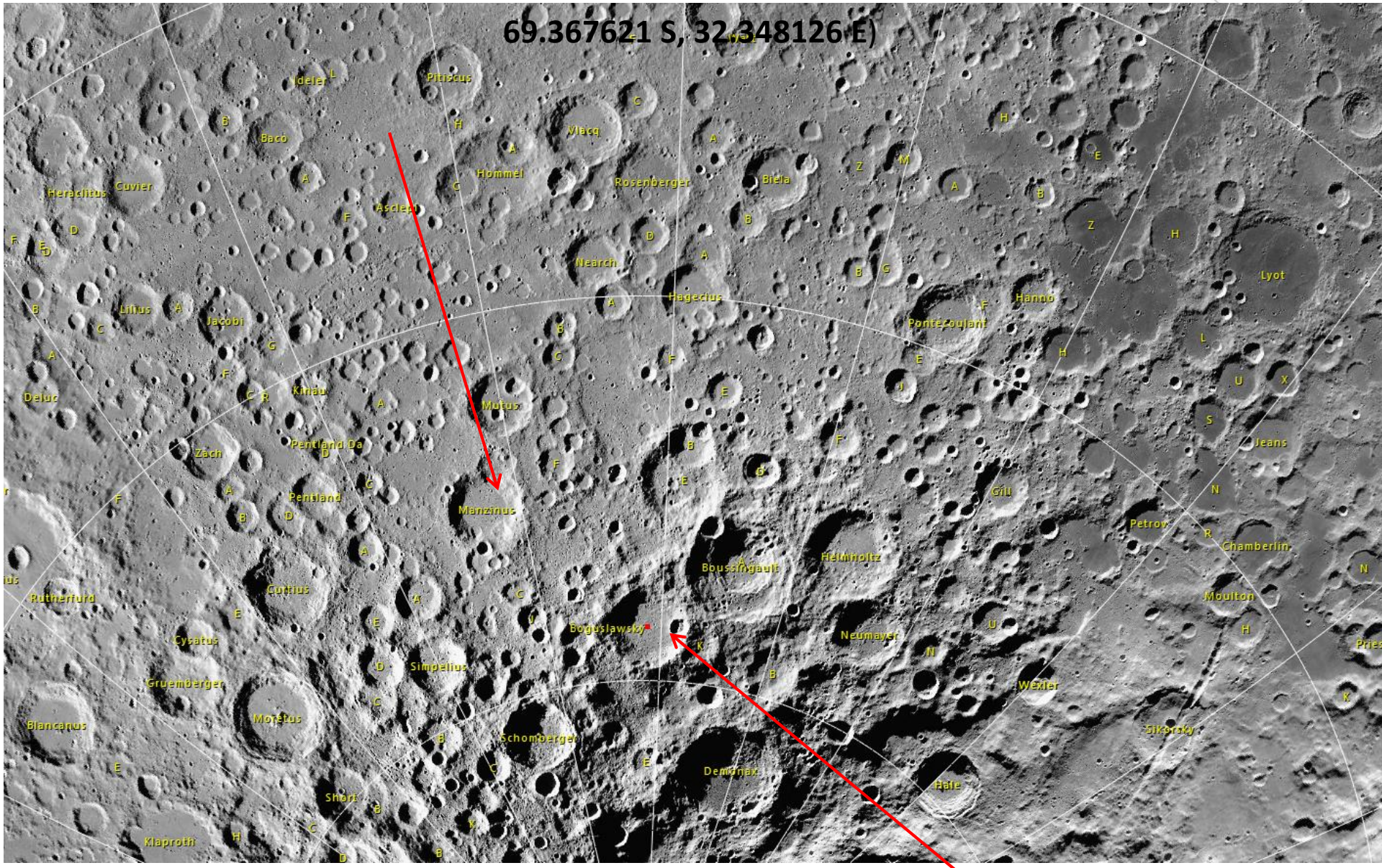
Chandryaan-3 Landing Site

69.367621 S, 32.348126 E)





Luna 25 and Chandrayaan-3 Sites



Thank you

Any questions?