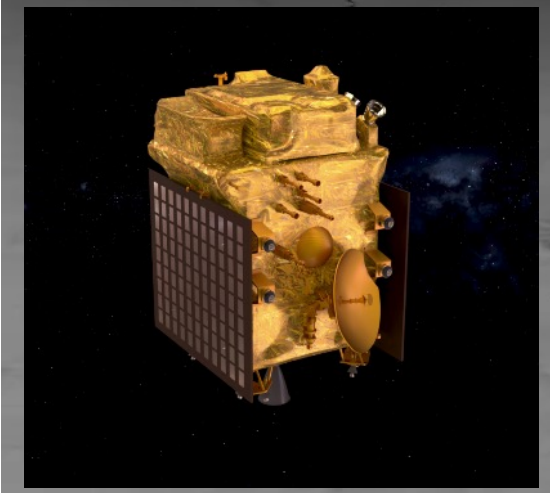
India's Science Missions:
CHANDRAYAAN-3 & ADITYA-L1



Shantanu Bhatawdekar
Scientific Secretary, ISRO

Presentation to
67th Session of UNCOPOUS
June 21, 2024

Evolution of Indian Lunar Exploration Programme

CHANDRAYAAN 1

(2008)

Reaching the moon
Impacting with probe
Scientific Experiments

CHANDRAYAAN 2

(2019)

Full fledged Orbiter
Lander & Rover
Scientific Experiments

CHANDRAYAAN

(2023)

Prime focus: Soft Landing
Lander & Rover
Scientific Experiments

Chandrayaan-1: Reaching the moon

Total Satellite Mass: 1380 kg
Designed Life: 2 Year

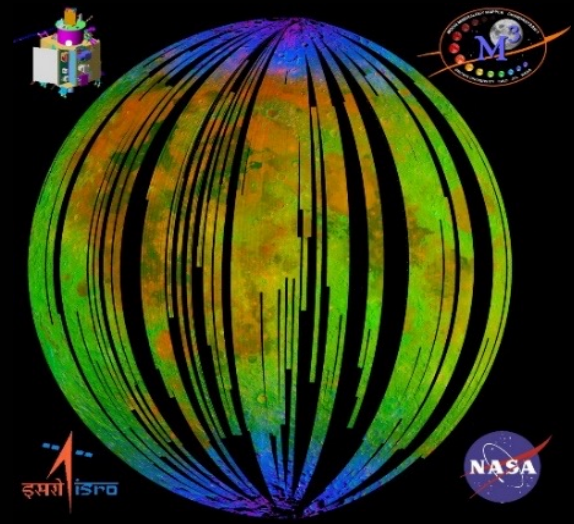
Payloads

India: 5
Europe + India: 2
Europe: 2
USA: 2

Launch: 22 October 2008
End of mission : 30 August 2009

High resolution imaging of the Moon; Mineralogical & Chemical mapping of the lunar surface

3D maps - craters & terrain

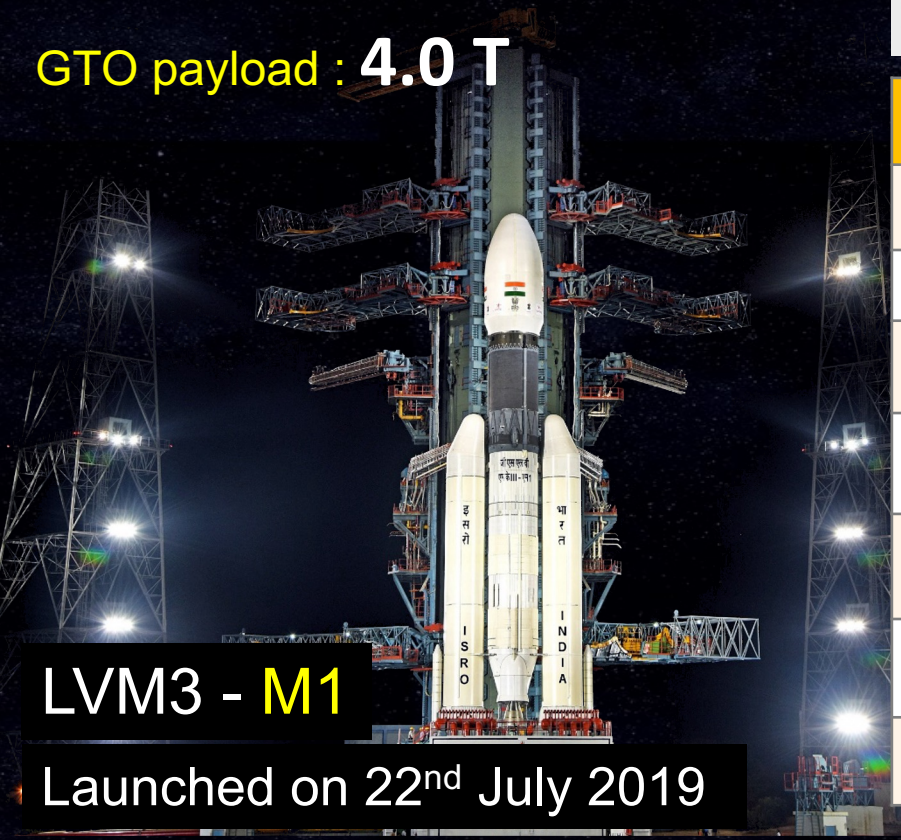


- Presence of Hydroxyl & water molecules on lunar surface (M3)
- Detection of Mg, Al, Si, Ca on lunar surface
- Detection of Argon-40 in the lunar exosphere

Chandrayaan-2: Landing attempt

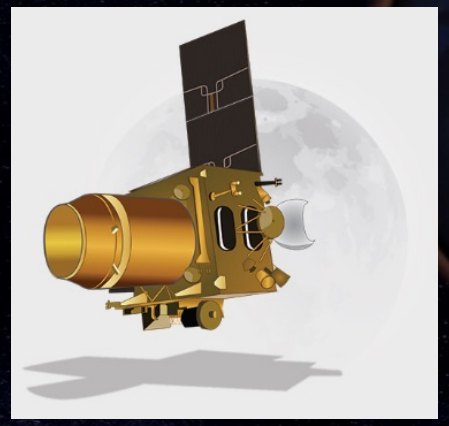
Total Spacecraft Mass: 3877 kg
Designed Life: 1 Year
Expected Life: 7.5 Years

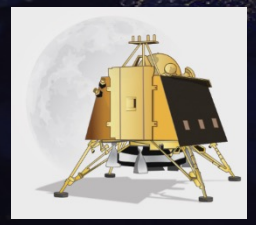
Lift off mass : 641 T
GTO payload : 4.0 T

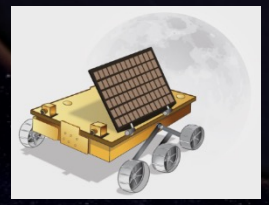


LVM3 - M1

Launched on 22nd July 2019





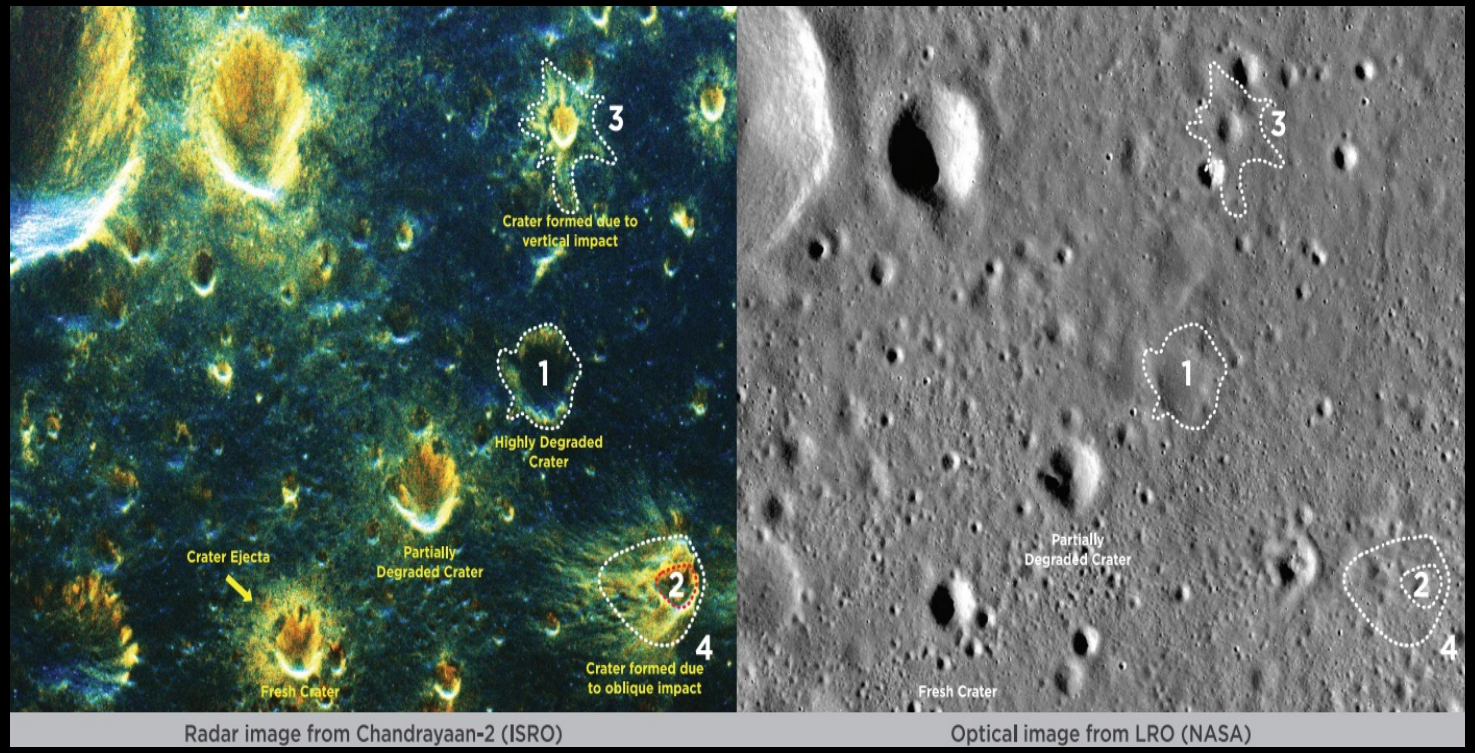


Inserted into lunar orbit on 20th August 2019

Achieved 100km orbit on 2nd September 2019.

Orbiter High Resolution Camera **(OHRC)**	Optical Images ~25 cm
Terrain Mapping Camera (**TMC**)	High-res topographic maps and DEMs.
Large Area Soft X-ray Spectrometer **(CLASS)**	Generation of global elemental maps
Solar X-ray Monitor **(XSM)**	Solar flux measurements for supporting CLASS.
Imaging Infra-Red Spectrometer **(IIRS)**	Mapping minerals in 0.8 to 5.0 micron
DF Synthetic Aperture Radar **(DFSAR)**	Full polarimetric measurements of PSRs
Atm. Composition Explorer – 2 **(CHACE-2)**	Study of neutral species in the exosphere
DFRadio Science Experiment **(DFRS)**	Lunar charged and neutral environment studies.

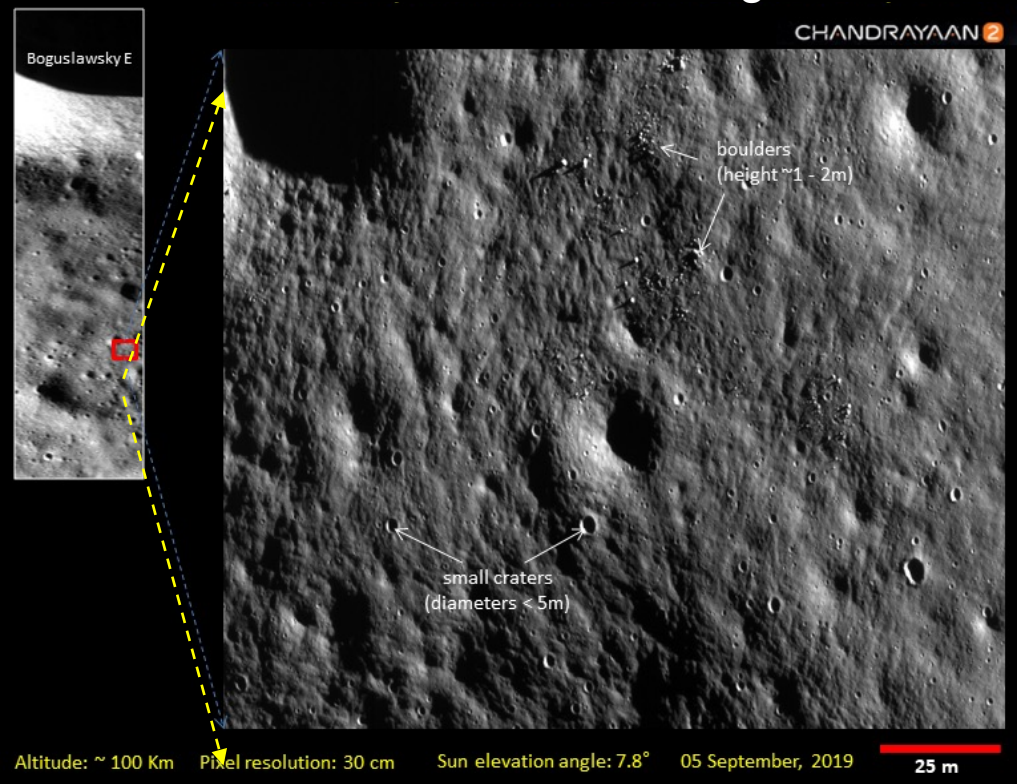
Chandrayaan-2 Orbiter Images of Moon



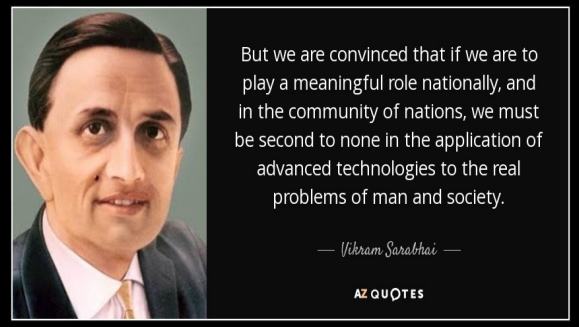
Radar image from Chandrayaan-2 (ISRO) | Optical image from LRO (NASA)

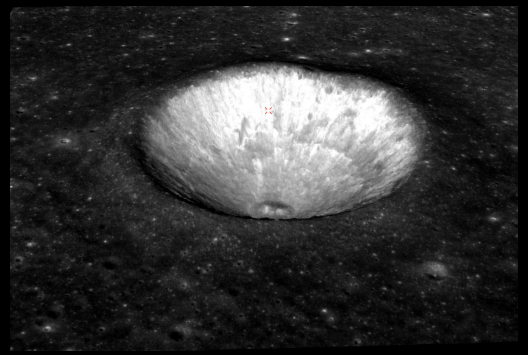
L-Band Synthetic Aperture Radar reveals craters hidden below the surface (1,2) and disturbed regions (3,4) hidden by lunar regolith

Center co-ordinates
Lat: 74.623 S, Long: 54.087 E



Sharpest images ever from a lunar orbiter platform





Crater Centre location:
24.742 N, 21.00 E

Diameter of Crater~8 km
Depth of Crater~1.7 km

Sarabhai crater on the Moon imaged by TMC-2

Chandrayaan-3 : Safe & Soft Landing

Lander Module

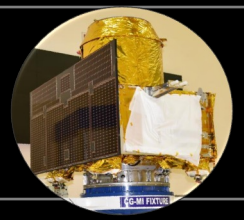
Mass: 1750 kg
Power: 738W
Payloads : 3

Rover

Mass: 26 kg
Payloads : 2
Power : 50 W

Propulsion Module

Mass: 2145 kg
Power: 758W
Payload : 1



Safe and Soft Landing

On Orbit Testing & Evaluation

Ground Tests & Simulations

Robustness built in Lander

CH-2 On orbit experience addressed

Chandrayaan-2 heritage

01

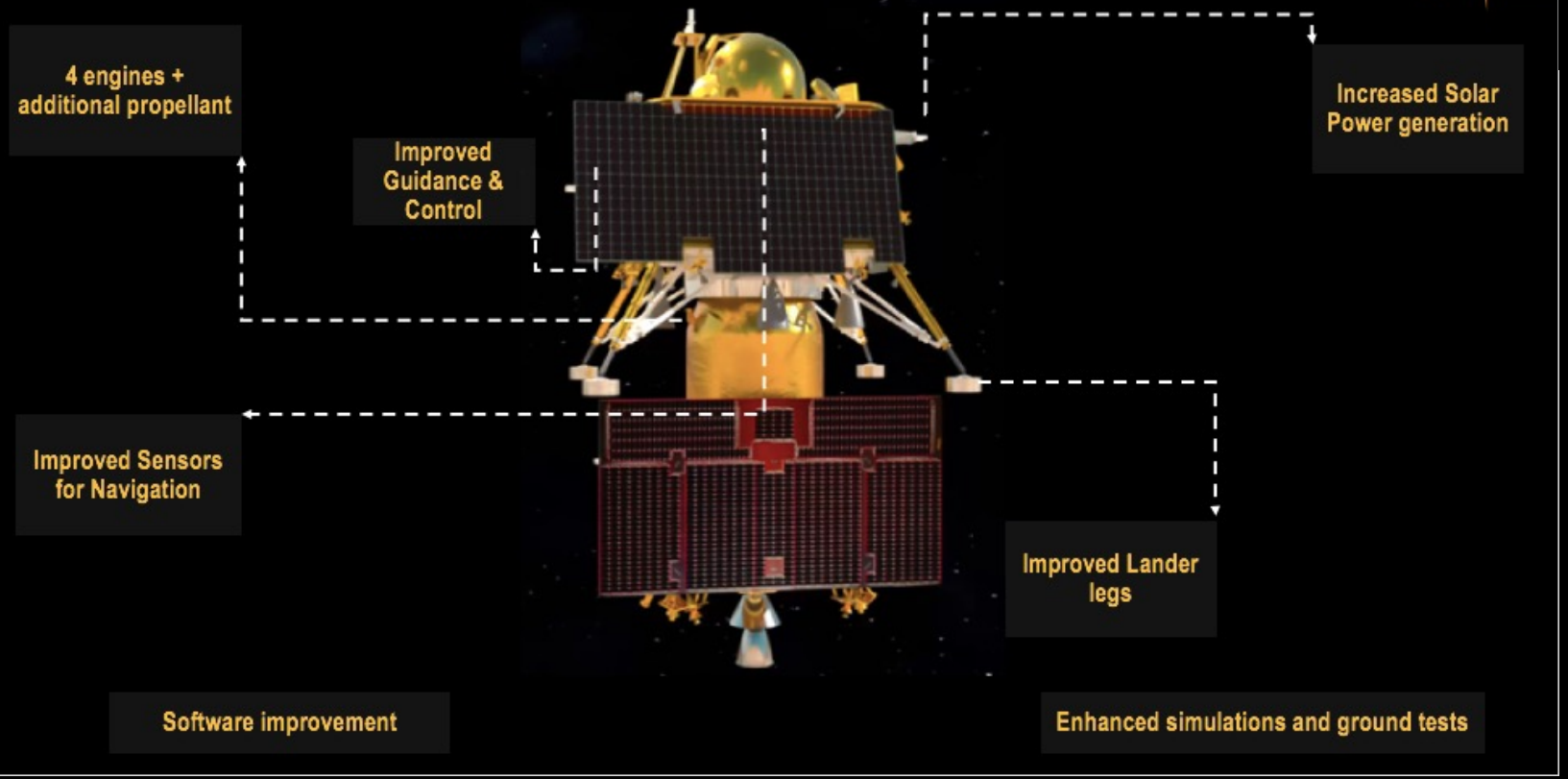
02

03

04

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

Improvements in Chandrayaan-3



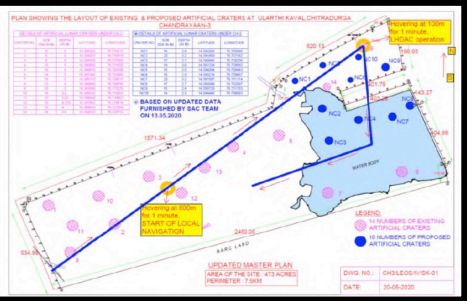
Special tests & Simulations

- Autonomous 6 DoF Simulation
- Software In Loop Simulation
- Hardware in Loop Simulation

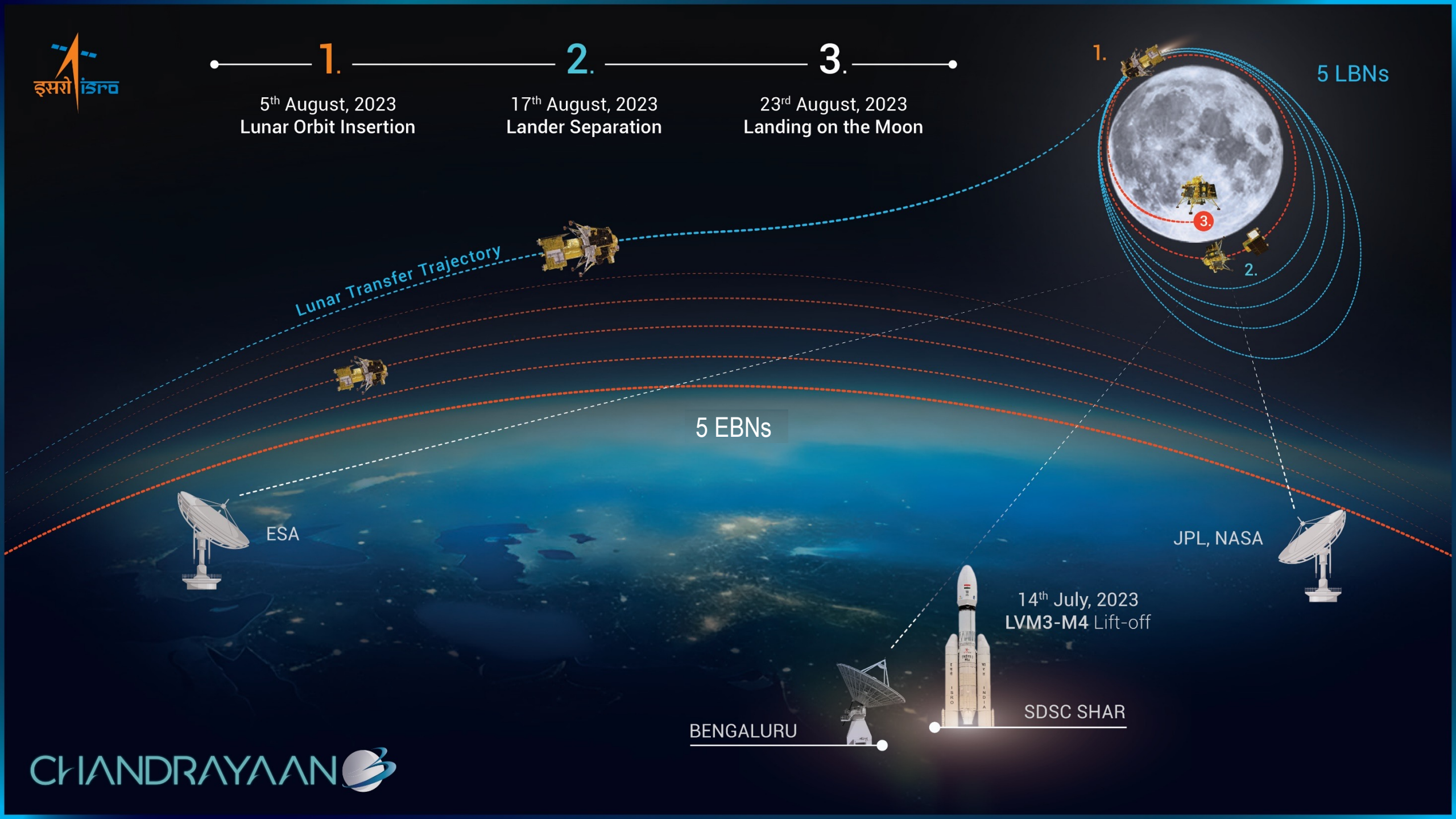
Integrated Cold Test

Integrated Hot Test

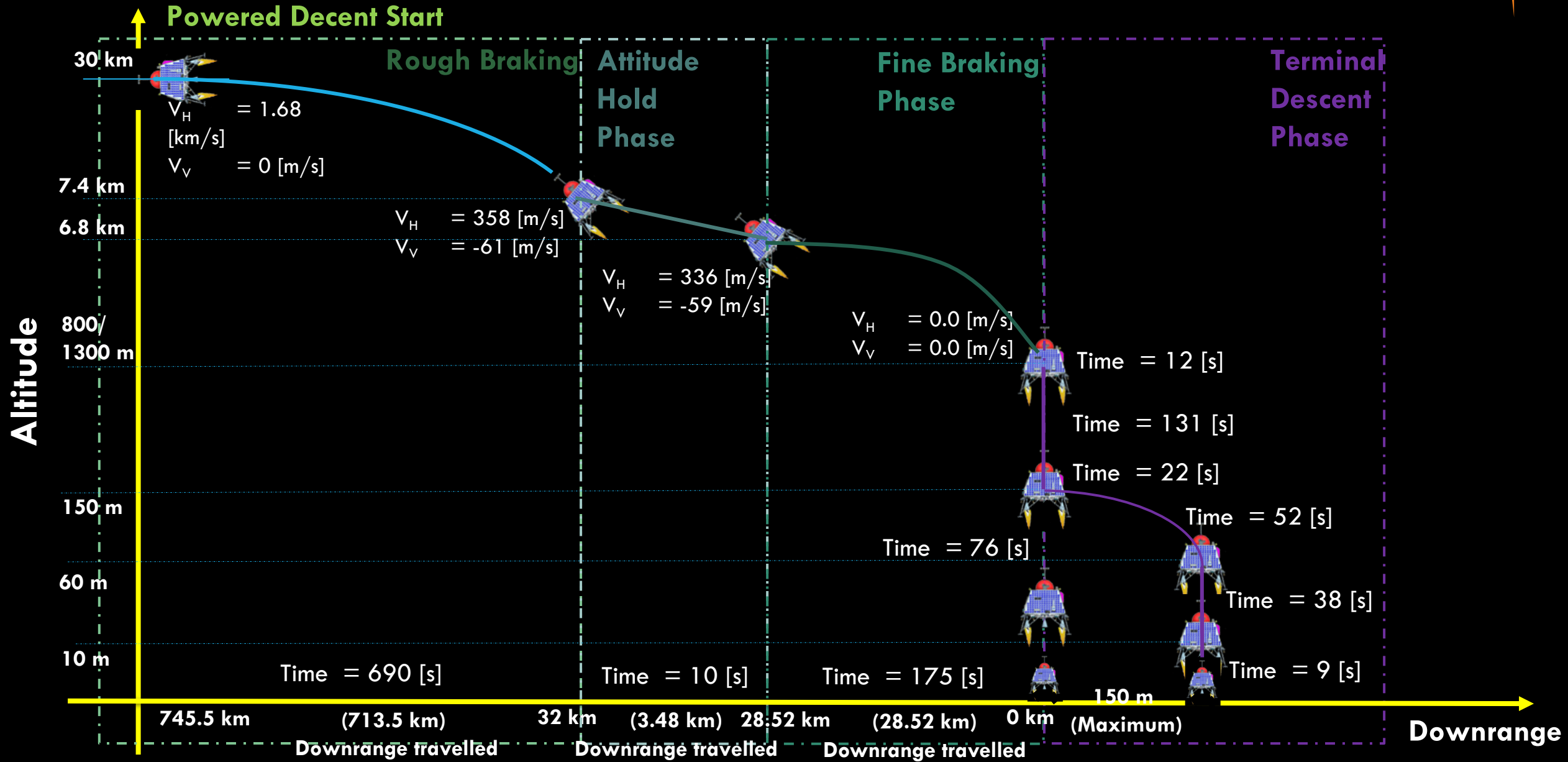
Lander Leg Drop Test



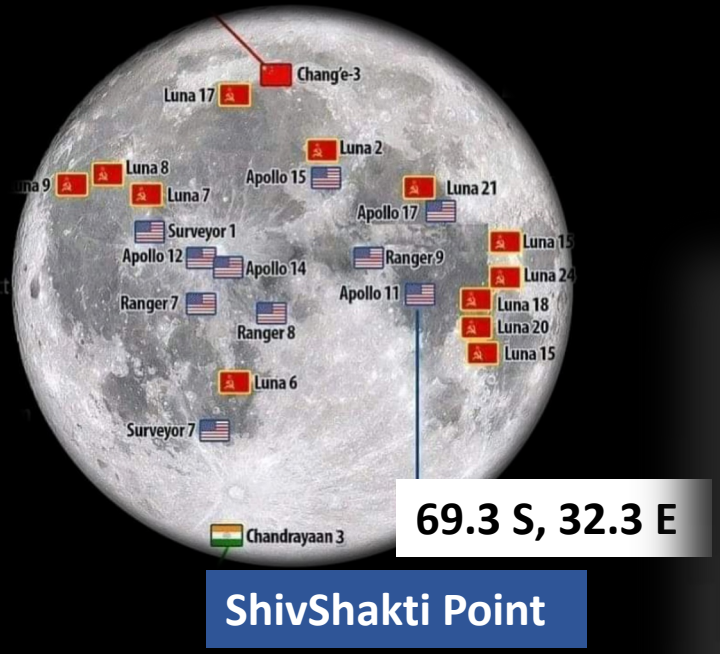
To validate the performance of sensors and navigation, under different test configuration and flight profile.


इसरो isro
1.
5th August, 2023
Lunar Orbit Insertion
2.
17th August, 2023
Lander Separation
3.
23rd August, 2023
Landing on the Moon
1.
5 LBNs
3.
2.
Lunar Transfer Trajectory
5 EBNs
ESA
JPL, NASA
14th July, 2023
LVM3-M4 Lift-off
SDSC SHAR
BENGALURU
CHANDRAYAAN

The Lunar Landing



Achieved soft landing on Moon on 23 August, 2023 at 18:04 IST



- ✓ India became the 4h country to have soft-landed on the Moon
- ✓ The 1st country to have soft-landed in higher lunar latitude

SHIV SHAKTI POINT

First-Cut Observations from Chandrayaan-3

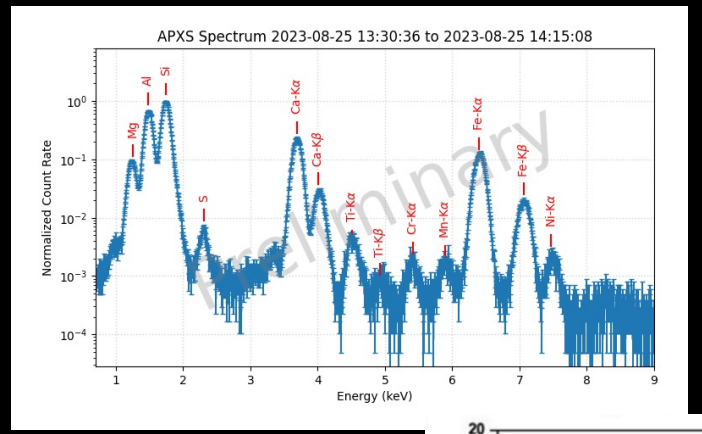
1. First-ever detection of **Sulphur** on the lunar regolith, along with trace constituents Aluminum, Calcium, Iron, Chromium, & Titanium on the lunar surface **(LIBS Payload)**

2. First-ever temperature profiling of the lunar regolith up to ~ 10 cm depth, results show good thermal insulating properties of the lunar soil **(ChaSTE payload)**

3. A few events of ground vibrations of the lunar surface are recorded **(ILSA payload)**

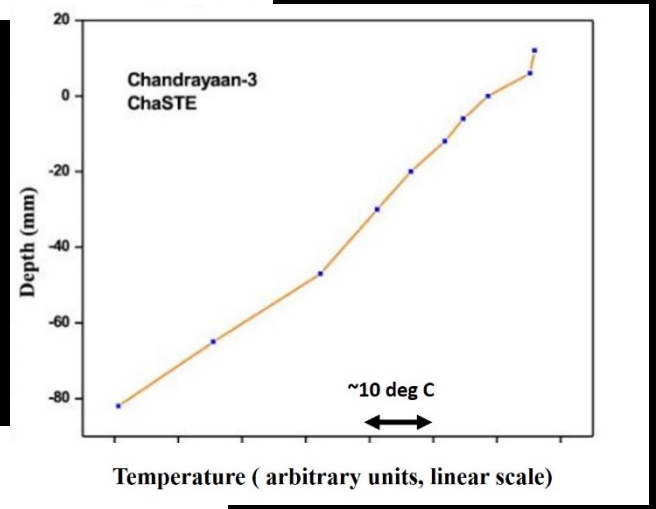
4. First-ever characterization of the near-surface lunar plasma at higher lunar latitude; indicate that only a few tens to hundreds of electrons per cc; dependence on local time **(RAMBHA-LP payload)**

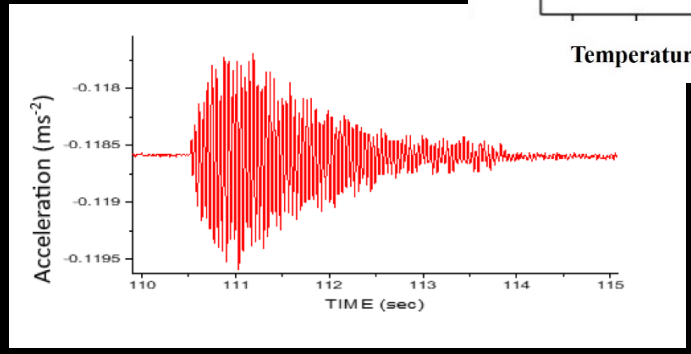
(detailed analyses in progress)



Elemental composition

Temperature profile

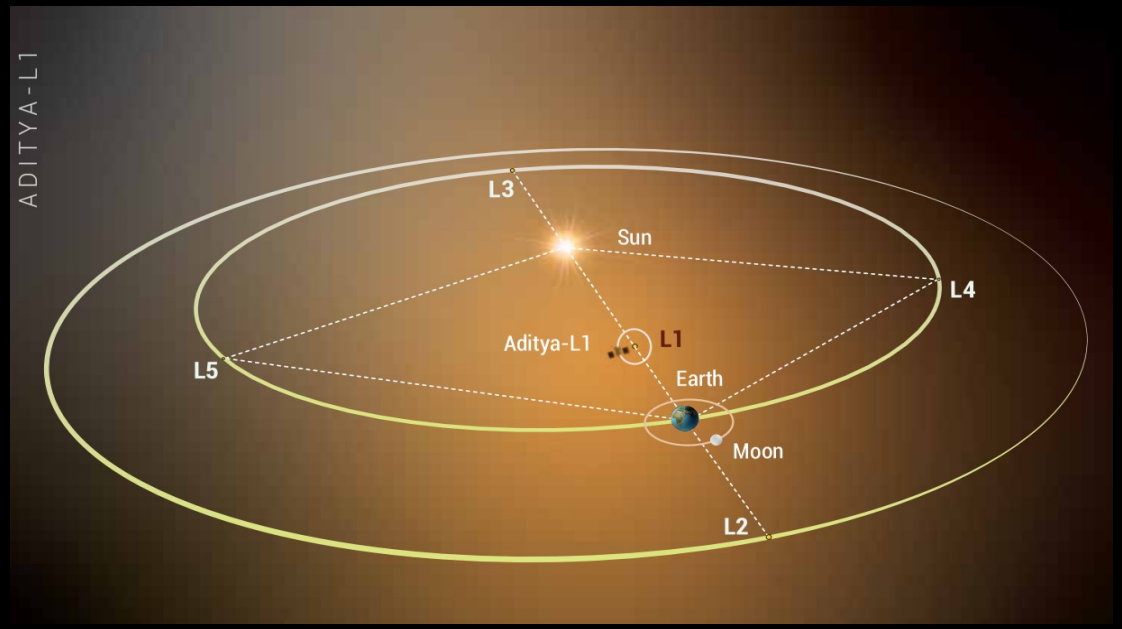




Vibration event

Aditya-L1: First Indian dedicated Mission to study the Sun

- **Halo orbit around the Lagrangian point 1 (L1) of the Sun-Earth system (at a distance of about 1.5 million km from the Earth).**
- **Major advantage: continuously viewing the Sun without any occultation/eclipses.**
- **Payload Verification (PV) phase is going on.**



Launched on 2nd Sep 2023

Halo Orbit Insertion on 6th Jan 2024

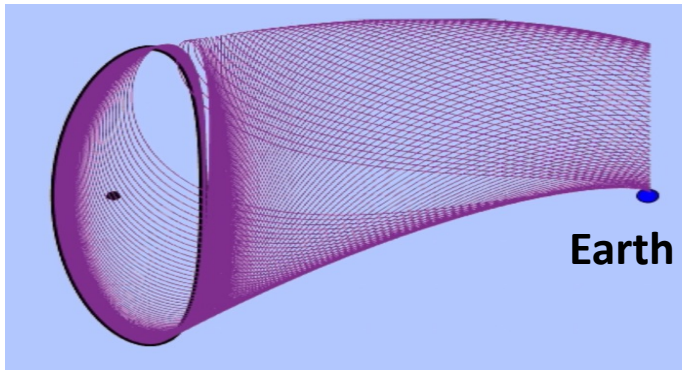
Sun's Radius : 0.7 M km

Distance from Earth: 150 M Km

Aditya-L1 Mission: Challenges in realization

✓ First Indian Mission to L1 - Trajectory Optimization:

- Launch vehicle capacity, launch window constraints & fuel minimization during Earth-bound manoeuvres, in cruise as well as orbit maintenance.



✓ Stringent pointing accuracy and stability:

- 15 arc-second pointing accuracy and spacecraft stability within 5 x 10-5 deg/s.

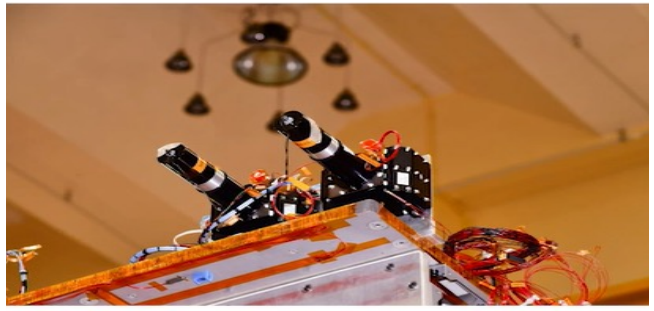
✓ Magnetic cleaning & sub-system magnetic field requirements:

- New harness routing developed to magnetically clean the spacecraft.

Sub-system magnetic field measurement facility

✓ Stringent contamination control requirements:

- Stringent contamination control for payloads & spacecraft. For VELC & SUIT payloads it is Class 100 requirements.

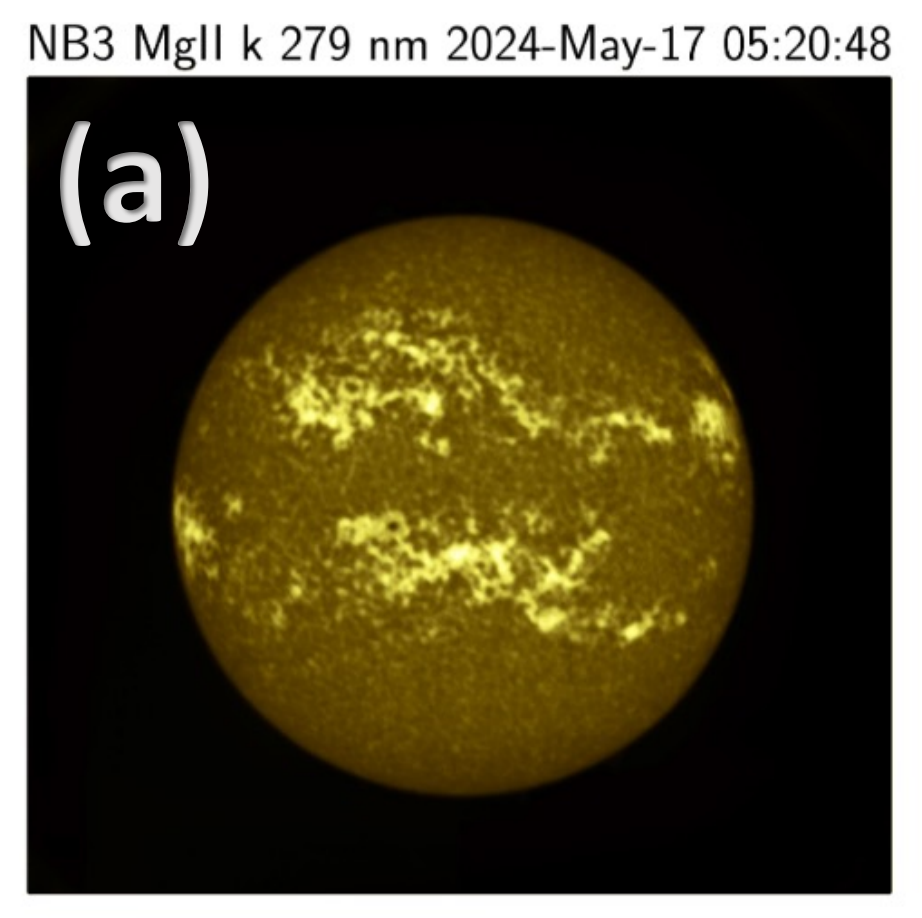


High-accuracy pixel sensor

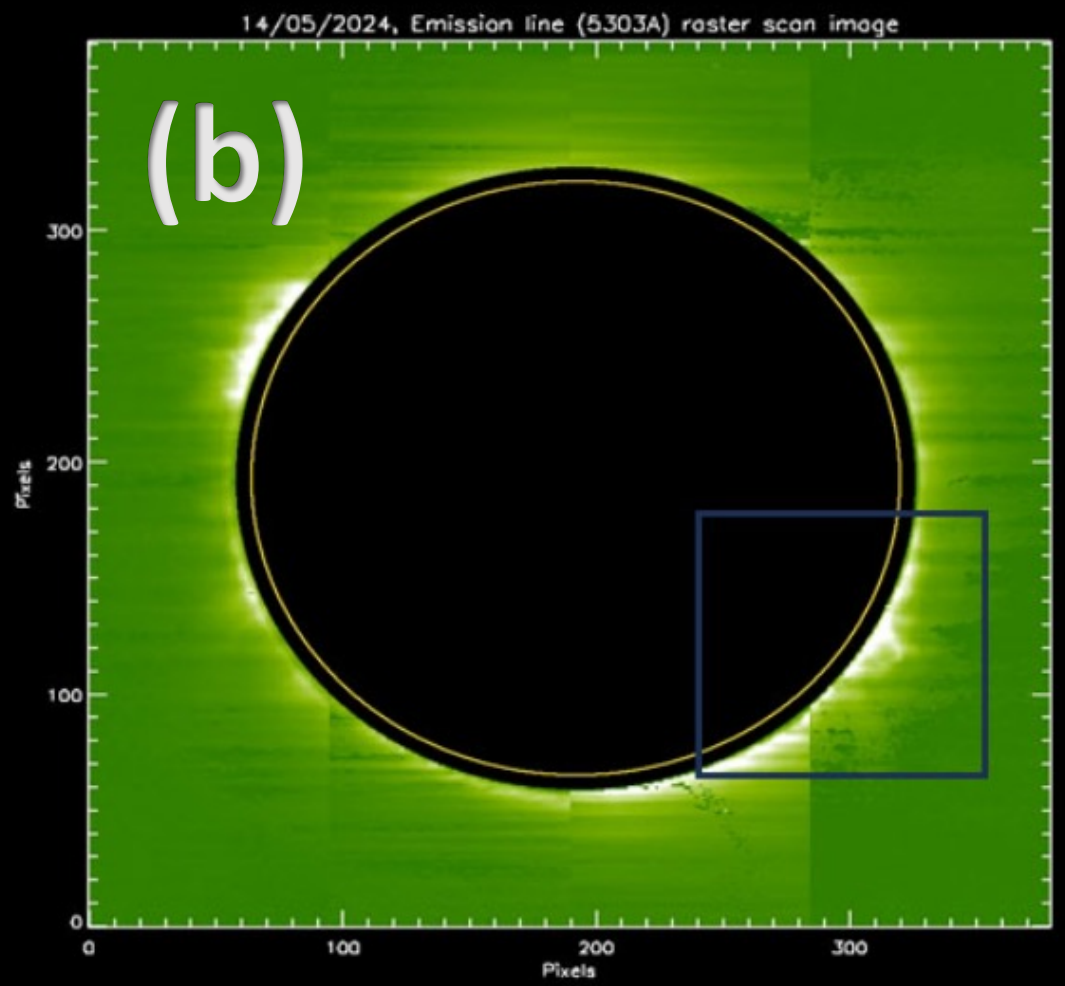
Magnetically suspended reaction wheels

Optical components

Capturing the recent solar fury....



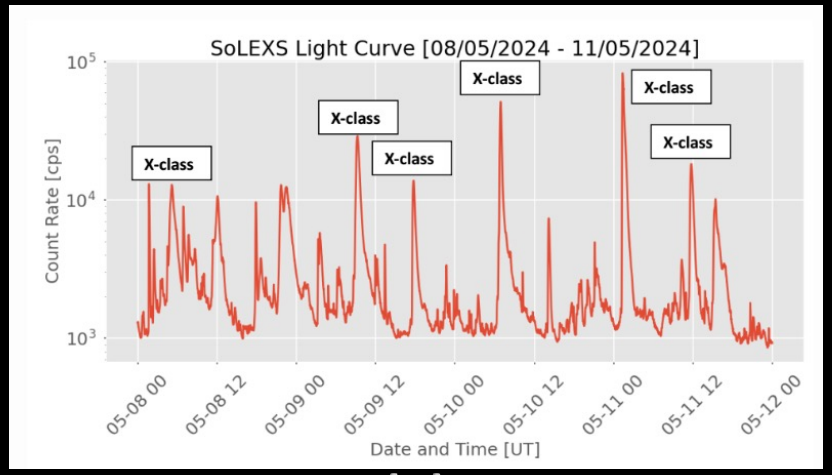
Sun image in Mg II k line using SUIT / AdityaL1



VELC observations made on May 14, 2024, at 5303 Angstrom. AR 13664 location is marked in this raster image as a box.

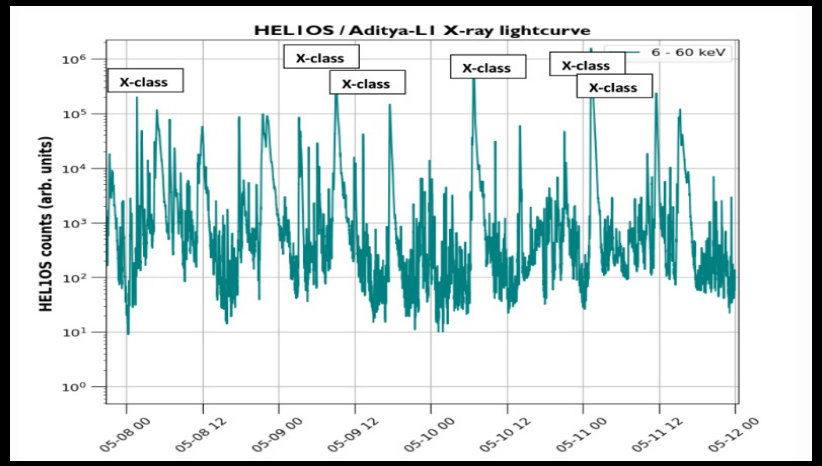
Capturing the recent solar fury….

SoLEXS: Low energy X-ray (1 – 22keV)



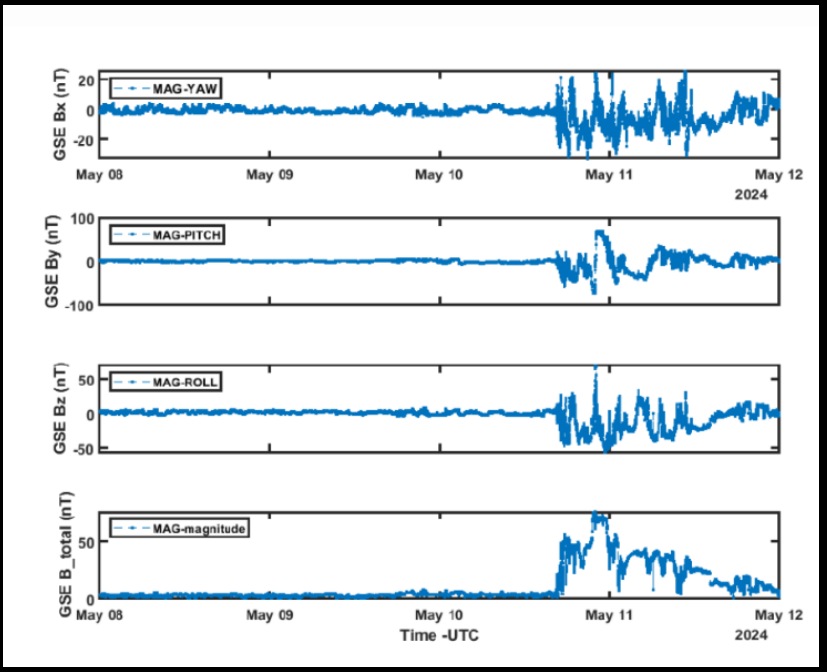
(c)

HEL1OS: High energy X-ray (8 – 200keV)

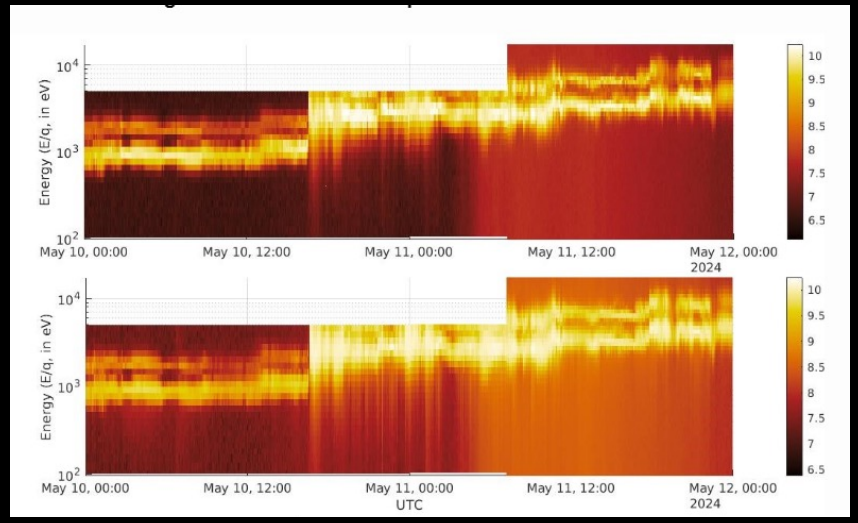


(d)

Disturbance of the IMF : MAG/Aditya-L1



(e)



Proton (lower) and alpha (upper) lines: ASPEX/Aditya-L1

(f)

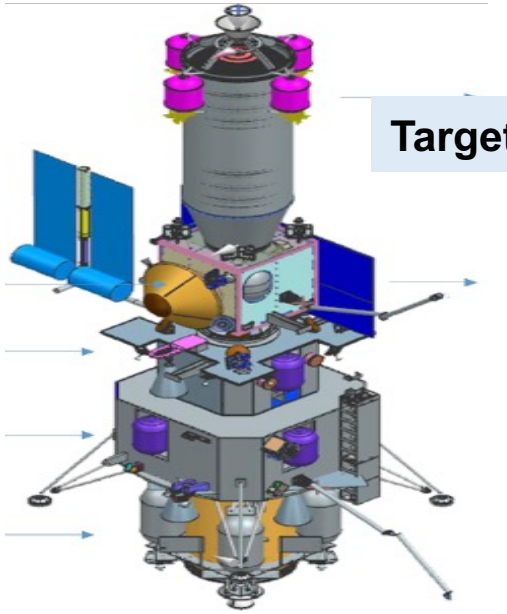
Sample Return from Moon ……. Under Configuration

1

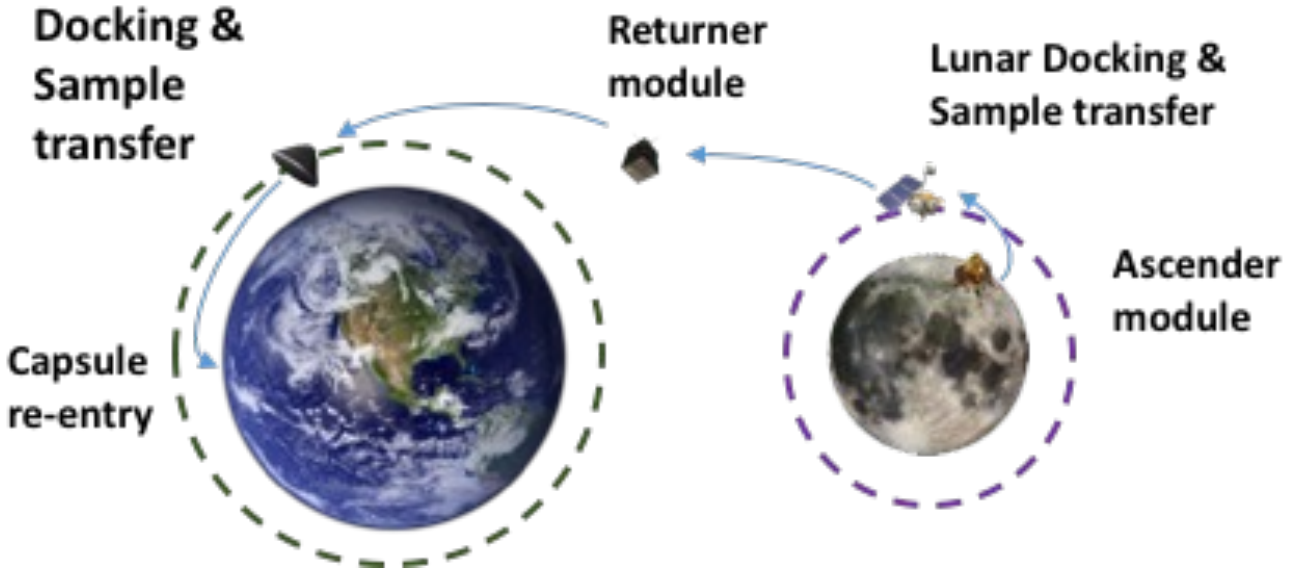
1st module launch by LVM3

2

2nd module launch by LVM3



Target: 2027



Technology elements

- Lunar Sampler (Robotic Arm)
- Ascender module
- Docking in Lunar / Earth Orbits
- Sample transfer
- Return & re-entry

Thank You …