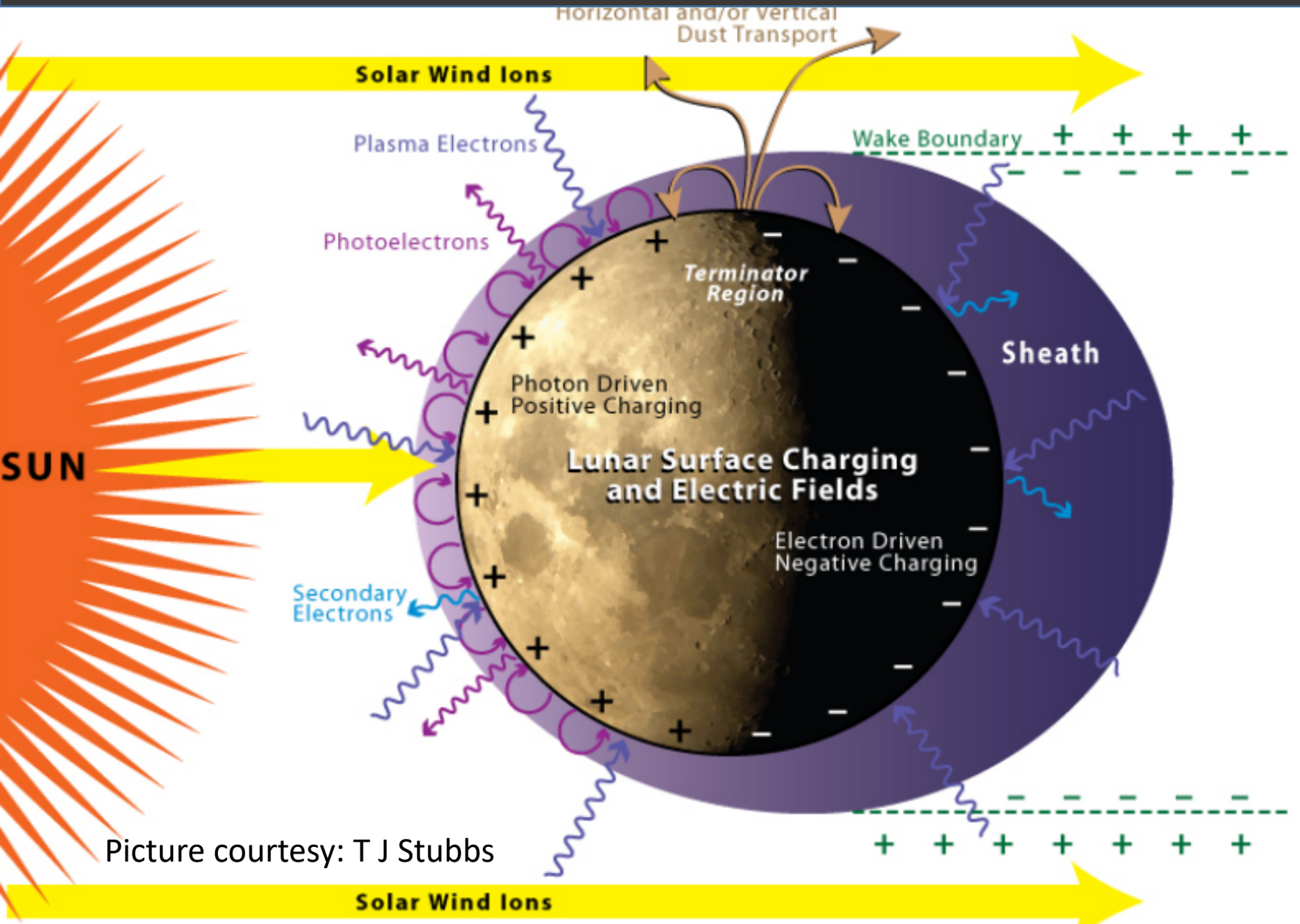
Chandrayaan3 Mission

Scientific Motivation for Indian Lunar Exploration



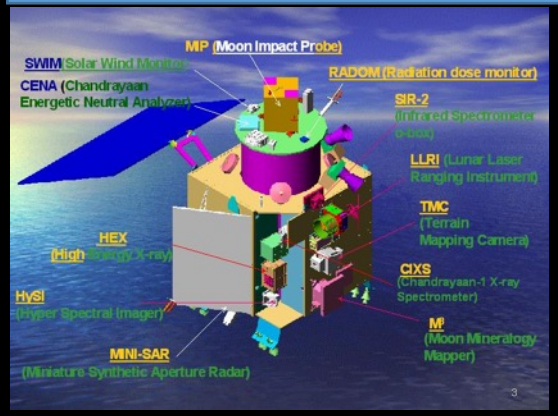
Picture courtesy: T J Stubbs

- Airless body → All the wavelengths unhindered (since no thick atmosphere)
- No Global Magnetic Field→ Exposed directly to the solar wind (H+, He++, other ions PLUS electrons)

Domains for Study:
Elemental composition, mineralogy, geology; Exosphere studies; Particle environment

India's Lunar Science Programme: Scientific Rationale

Chandrayaan-1 (2008)



Indian

- ❑ HYSI
- ❑ TMC
- ❑ LLRI
- ❑ HEX
- ❑ MIP

European-Indian

- ❑ C1xS
- ❑ SARA

United States

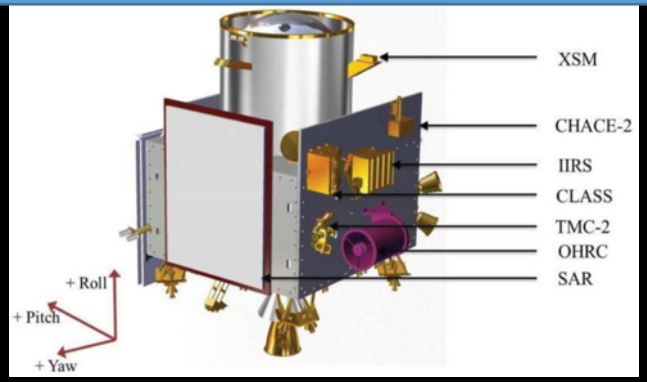
- ❑ M3
- ❑ Mini-SAR

European

- ❑ SIR-2
- ❑ RADOM

"Chemical, mineralogical, geologic mapping of the Moon"

Chandrayaan-2 (2019)



- Orbiter High Resolution Camera (OHRC)
- Terrain Mapping Camera – 2 (TMC-2)
- Chandrayaan-2 Large Area Soft X-ray Spectrometer (CLASS)
- Solar X-ray Monitor (XSM)
- Imaging Infra-Red Spectrometer (IIRS)
- Dual frequency Synthetic Aperture Radar (DFSAR)
- Chandra's Atmospheric Composition Explorer – 2 (CHACE-2)
- Dual Frequency Radio Science Experiment (DFRS)

Chandrayaan-3 (2023)

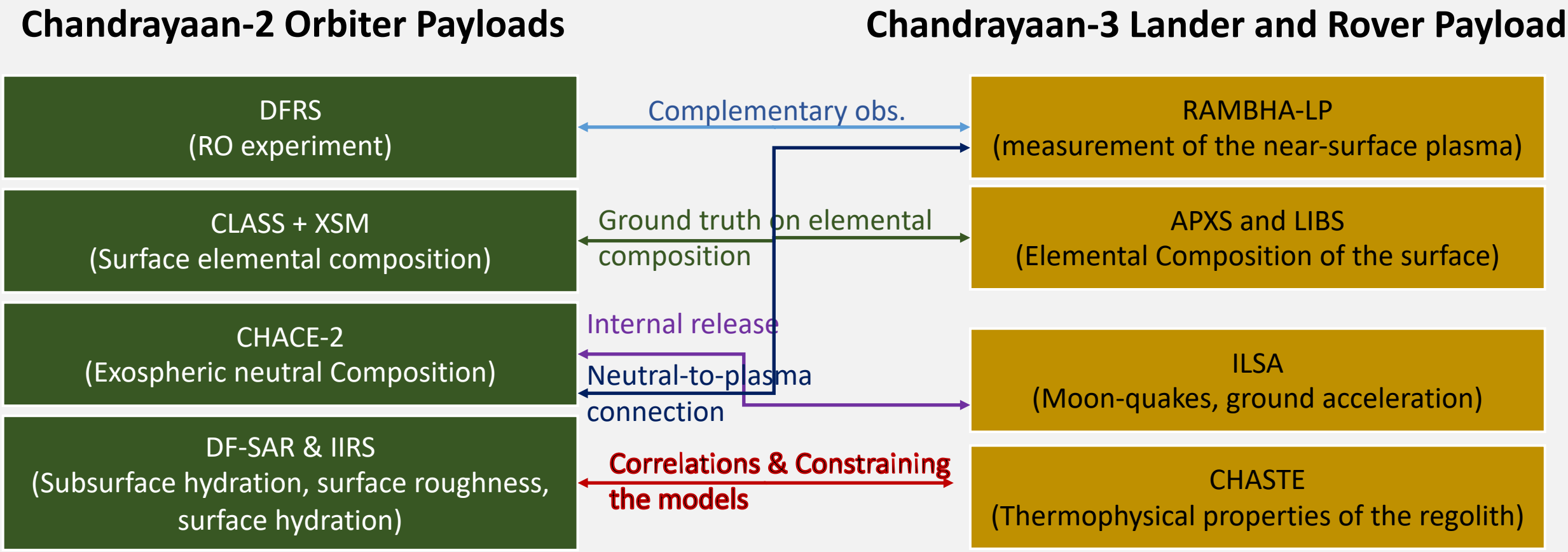
- Instrument for Lunar Seismic Activity (ILSA)
- Radio Anatomy of Moon Bound Hypersensitive ionosphere and Atmosphere (RAMBHA) – Langmuir Probe (RAMBHA-LP)
- Chandra's Surface Thermo-physical Experiment (ChaSTE)
- Alpha Particle X-Ray Spectrometer (APXS)
- Laser Induced Breakdown Spectroscope (LIBS)
- Spectro-polarimetry of HAbitable Planet Earth (SHAPE)

"Ground truth of the surface and near-surface properties at the landing site"

From Chandrayaan-1 to Chandrayaan-2

Ch-1 payloads	Specifications	Ch-2 payloads	Improved Specifications	Enhanced science
HySI **SIR-2** **M3**	32 spectral bands 0.93 - 2.4 micron 0.7 – 3.0 micron	**IIRS**	256 spectral bands, 0.8 to 5.0 micron; Res. 0.020-0.025 micron	Unambiguous detection of OH, water and water-ice signatures.
Mini-SAR	S-band, circular polarimetry	**DFSAR**	L and S band	Greater depth of penetration (~5-10m i.e twice that of S-band); circular and full-polarimetry
ChACE-1 on MIP	1-100 amu; short duration	**CHACE-2**	1-300 amu; continuous	Global dynamics of exospheric species
C1XS	0.5 – 10 keV	**CLASS**	0.8 – 15 keV, ~ 3 times larger area, 12.5 km resolution	High resolution elemental maps, minor elements detection, geotail studies
SXM	1–20 keV; 250 eV at 6 keV	**XSM**	1 – 15 keV; ~180 eV @5.89 keV	Better resolution and high cadence
TMC-1	Panchromatic	**TMC-2 + OHRC**	Miniaturised version & Hi-res	Mass reduction & high-res imaging
RO Experiment	Single freq – S band	**DFRS**	Dual freq.- S and X bands	Vertical profiling of ionosphere, electron density measurements, mitigation of scintillation effects

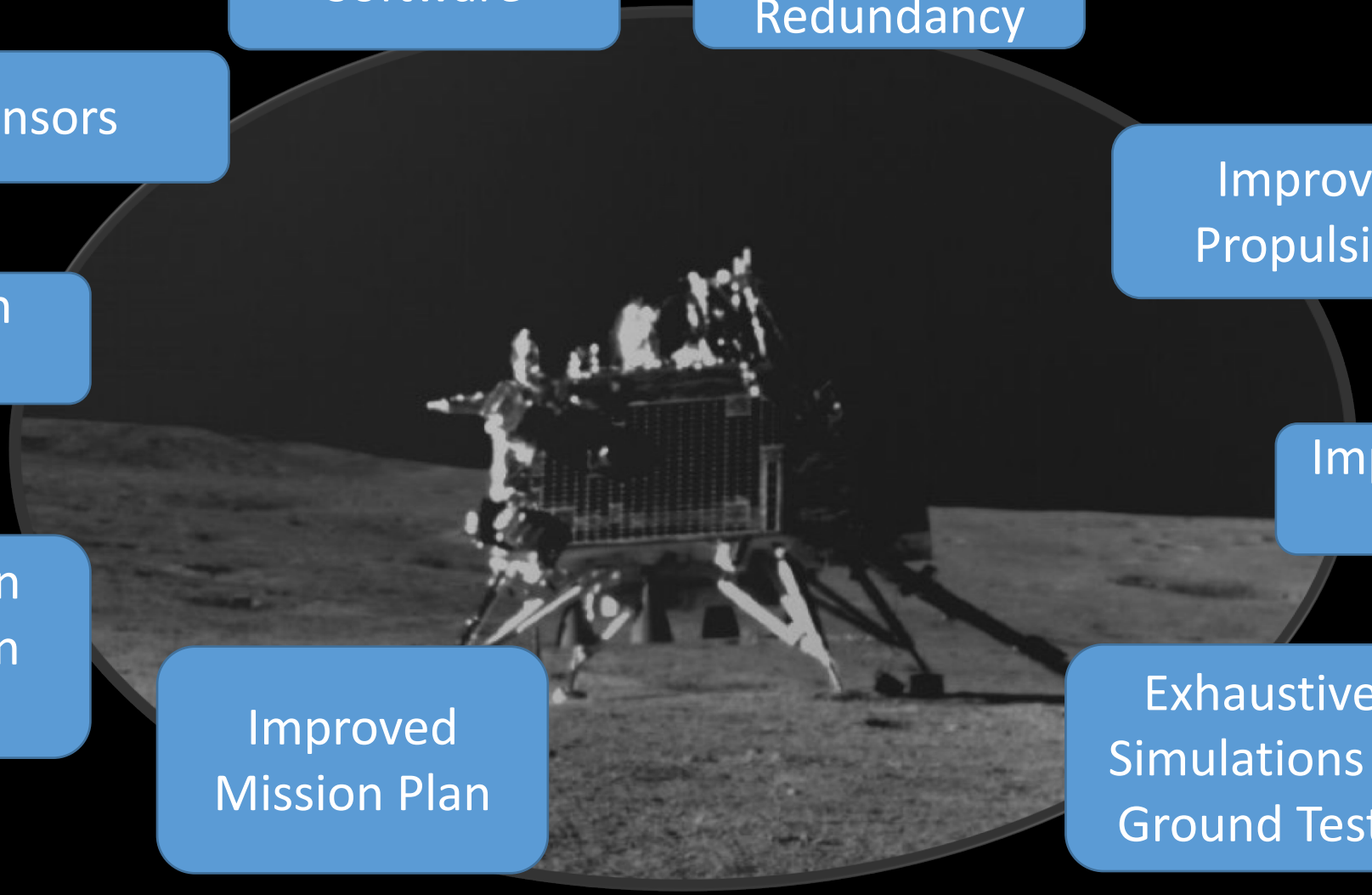
From Chandrayaan-2 (global) to Chandrayaan-3 (*in-situ*)



Local in-situ observations, plus looking for any variations of properties in the vicinity of the landing site

Improvements in Chandrayaan-3 Lander

Based on the lessons learnt from Chandrayaan-2 Lander



- Software
- Hardware Redundancy
- Sensors
- Improvements in Propulsion Module
- Propulsion System
- Improvements in NGC
- Re-work on touchdown limits
- Improved Mission Plan
- Exhaustive Simulations & Ground Tests

Choice of the Landing Site of Chandrayaan-3

Scientific

1. Higher latitudes are relatively unexplored
2. Unique condition – Sun shines at grazing angle → lesser deposition of energy, solar wind ions and electrons
3. Scientifically interesting Topography

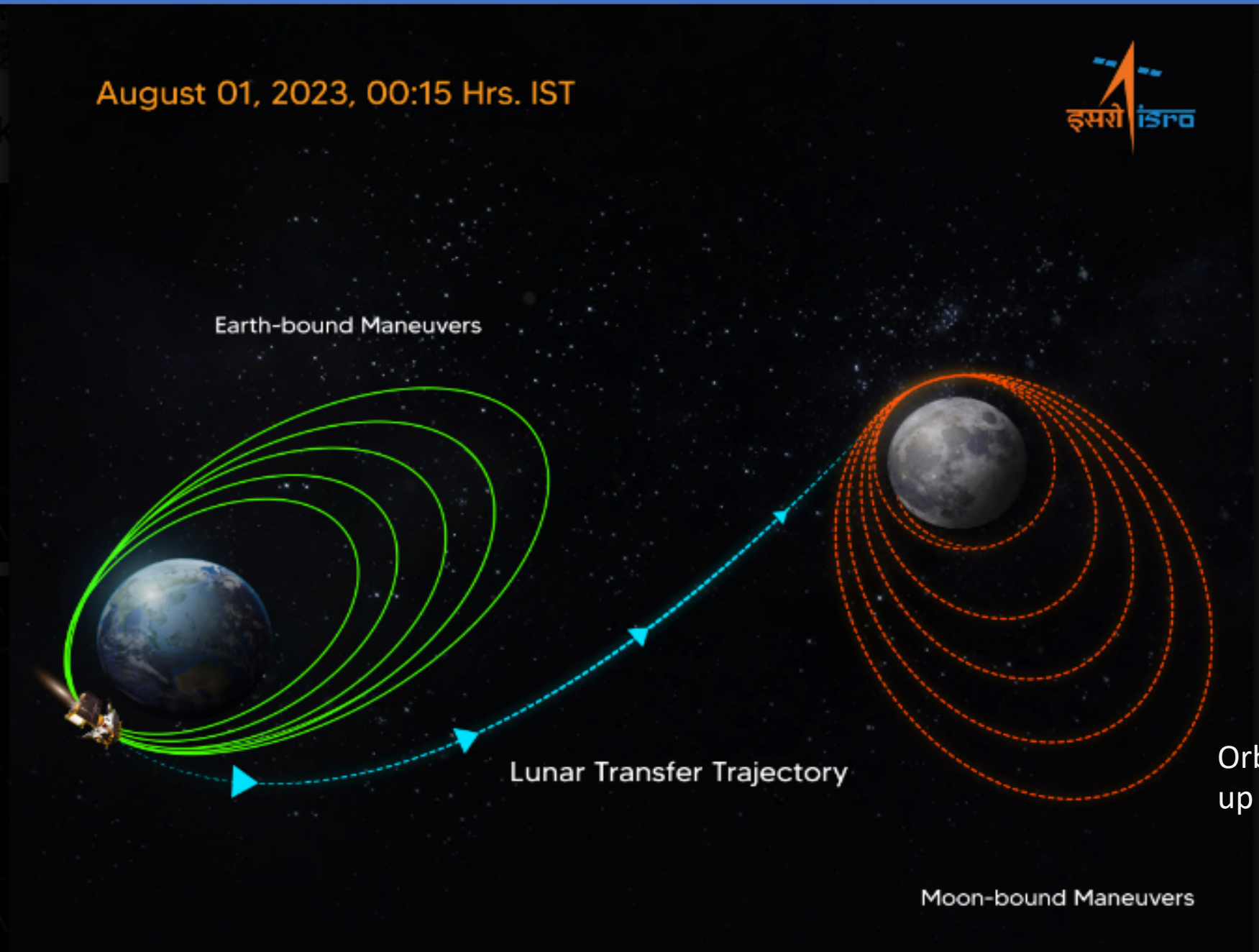
Technological

1. Conditions on global slope
2. Conditions on the sizes of boulders and crates
3. Shadow analysis; power generation
4. Communication with Earth

The Journey of Chandrayaan-3

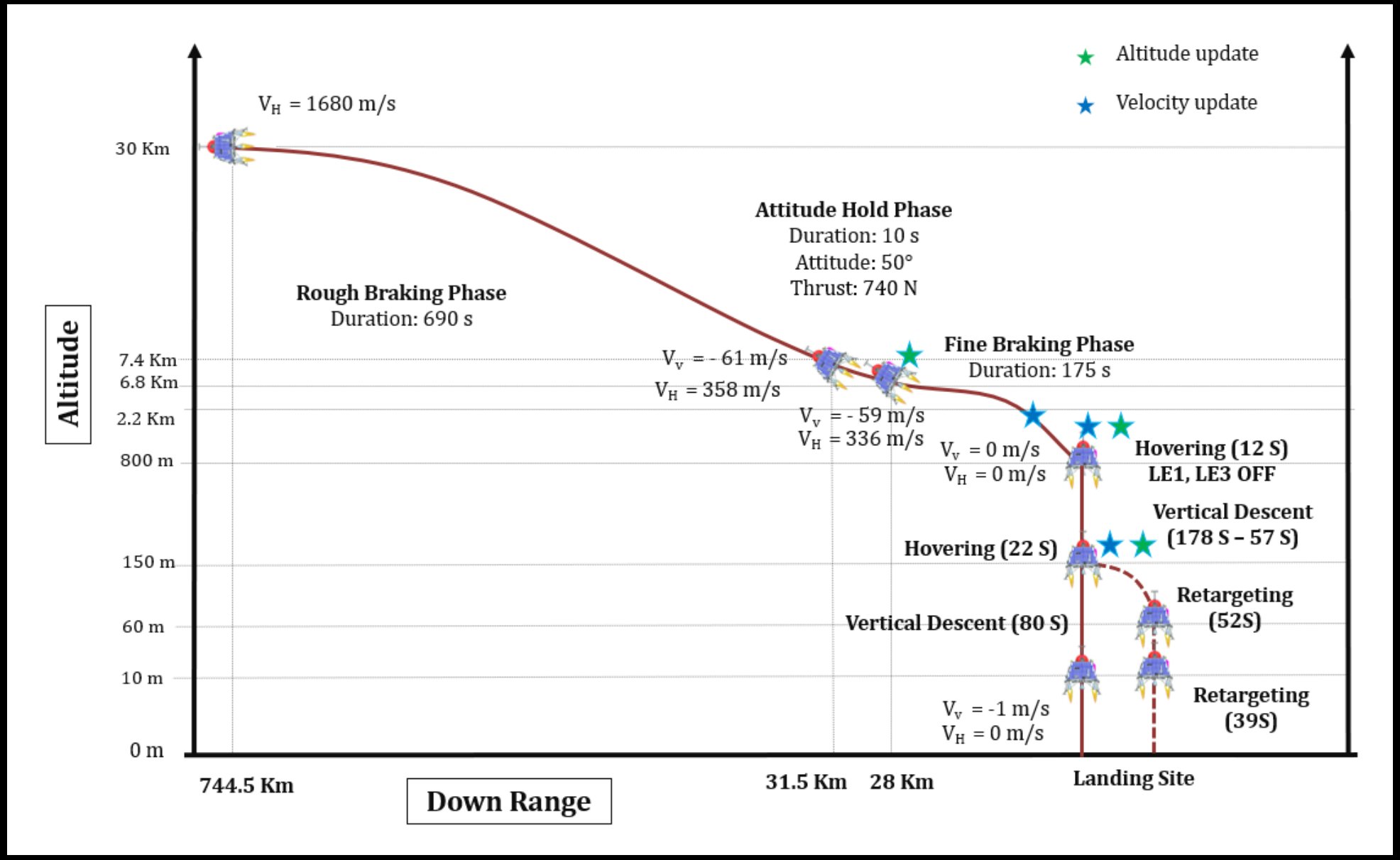
July 14, 2023, at 14:35 Hrs. IST from the Second Launch Pad, SDSC-SHAR, Sriharikota

The Journey of Chandrayaan-3 (contd.)



Orbits are not up to the scale

Landing Sequence of Chandrayaan-3



23 August, 2023, Wednesday, 18:04 IST

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CHANDRAYAAN

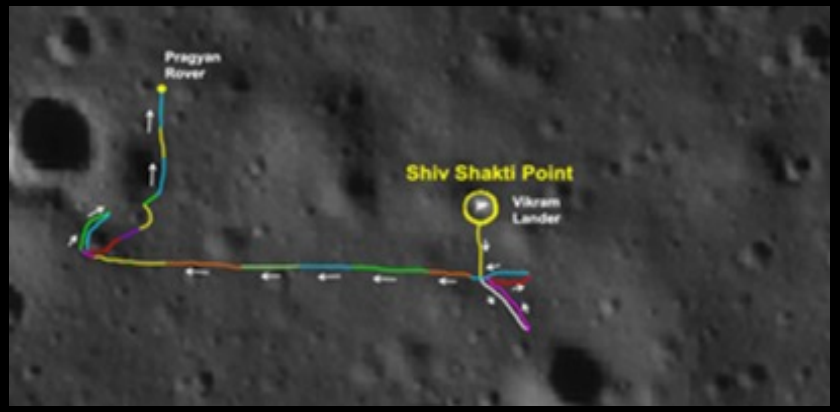
Achieved soft landing on the Moon

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

Chandrayaan-3 Mission Update

Aug 23, 2023: Ch-3 soft-landed on Moon

Vikram Lander on Lunar Surface: Picture taken by the Pragyan Rover



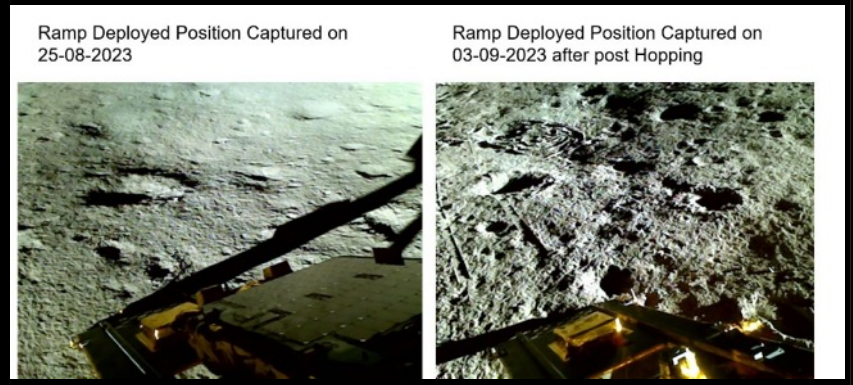
Total distance travelled by Pragyan: ~ 101 m

Original Mission Objectives

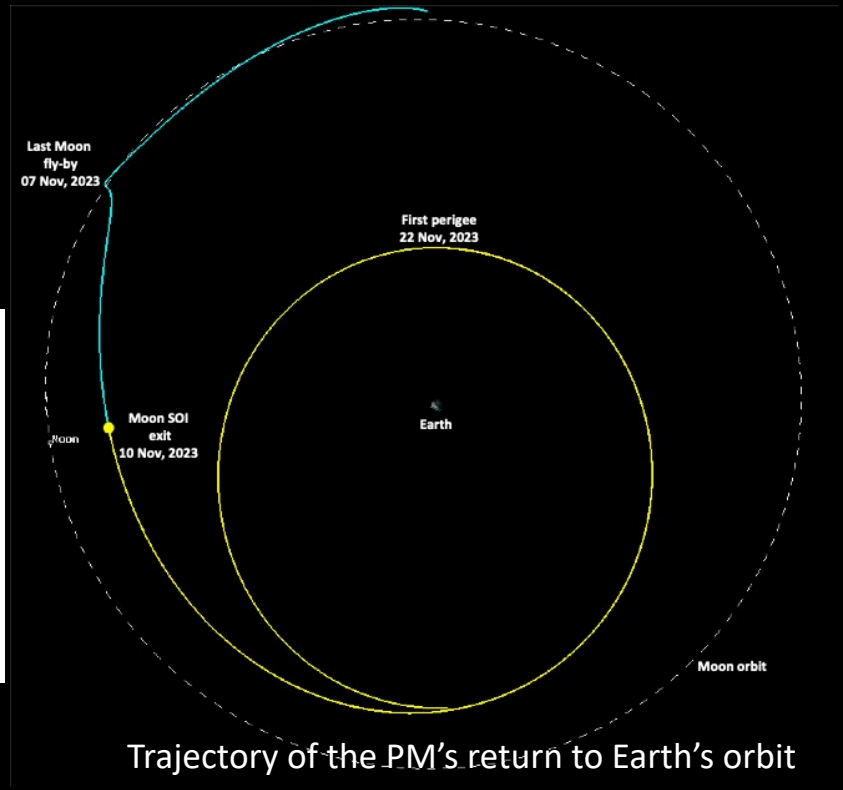
- To soft-land the lunar lander-rover module on the pre-determined landing site at the Southern higher latitudes of the Moon
- Demonstration of the rover movement on the lunar surface

Extended Mission Accomplishments

- Demonstration of hopping of the lander by re-firing the engines – Sep 3, 2023
- Return of the propulsion module (PM) to the Earth's orbit



Pre and Post hop ramp images captured by LI-1 cam



Trajectory of the PM's return to Earth's orbit

Preliminary steps towards Lunar Sample Return Mission

First-Cut Observations from Chandrayaan-3

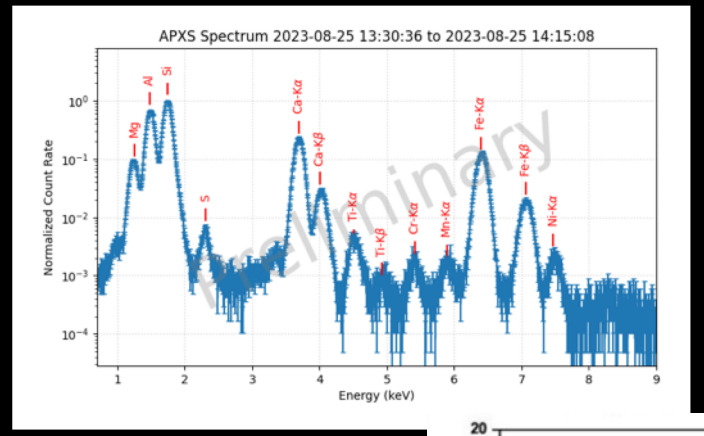
1. First-ever detection of S on the lunar regolith, along with trace constituents like C, N P Ti, Mn, Cr, Ni; quantification in progress

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

3. A few events of ground vibrations of the lunar surface are recorded

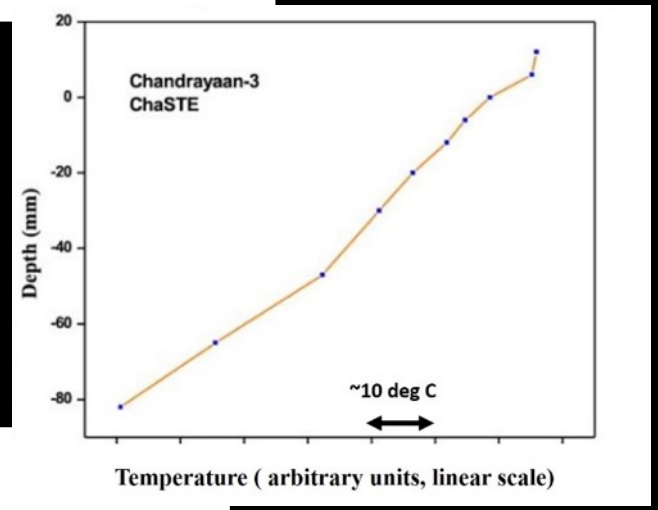
4. First-ever characterization of the near-surface lunar plasma at higher lunar latitude; indicate that only a few tens to hundreds of electrons per cc; dependence on local time

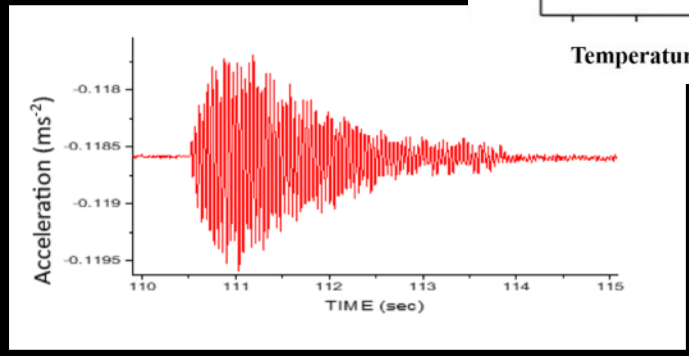
(detailed analyses in progress)



Elemental composition

Temperature profile





Vibration event

Thank You for Kind Attention