



42nd Annual Meet
Bengaluru, India
April, 2024

ISRO Status Report on Space Debris Related Activities (June 2023-April 2024)

Presented by
Indian Space Research Organisation (ISRO)

Launch and Re-entry Summary

Till Date	PSLV	GSLV (Including GSLV Mk III/ LVM3)
Total Launches	60	23
Successfully launched	58	19 (includes CARE suborbital flight)
Fragmented R/B	1	Nil
Decayed R/B	14	14
R/B remaining orbit	43	4

Within reporting period (June 2023-Apr 2024)

Launch Vehicles	Satellites Launched *	Post Mission Disposal/ decommissioning	Decayed/Re-entry
<ul style="list-style-type: none"> • PSLV-C56** • PSLV-C57 • PSLV-C58 • LVM3-M4 • GSLV-F14 	<ul style="list-style-type: none"> • Chandrayaan-3 • Aditya-L1 • XPOSAT-1 • INSAT-3DS 	<ul style="list-style-type: none"> • Cartosat-2 • IRS-P6/Resourcesat-1 • PSLV-C56 • PSLV-C58 	<ul style="list-style-type: none"> • Cartosat-2 • LVM3 M4 • PSLV-C56 R/B • PSLV-C58 R/B • 7 small satellites†

**7 Singaporean satellites launched by PSLV C56

†Sathyabamasat, SDSat, SWAYAM, INS-1A, INS-1B, Azaadisat, SindhuNetra

Major Highlights

Passivation of upper stages
of launch vehicles

Conjunction Assessment and Collision Avoidance

- Launch vehicle Lift-off clearance (COLA)
- Space Object Proximity Analysis (SOPA), collision avoidance

Post Mission Disposal

- De-orbiting of upper stages of PSLV
- PMD of Scatsat-1 initiated

Atmospheric re-entry analysis
for large objects and all
Indian objects

NETRA Project

- Optical telescope observational facility establishment
- Land identified for Radar facility

Tracking of LEO Objects by
Multi-Object Tracking RADAR
(MOTR) at SHAR

Space Object Tracking and Analysis

Multi Object Tracking Radar (MOTR)

L-band Phased Array Radar at Sriharikota, 10-object simultaneous tracking capability (50 cm size up to 800 km slant range), commenced object tracking after refurbishment and undergoing further assessments.

NEtwork for space object TRacking & Analysis (NETRA)



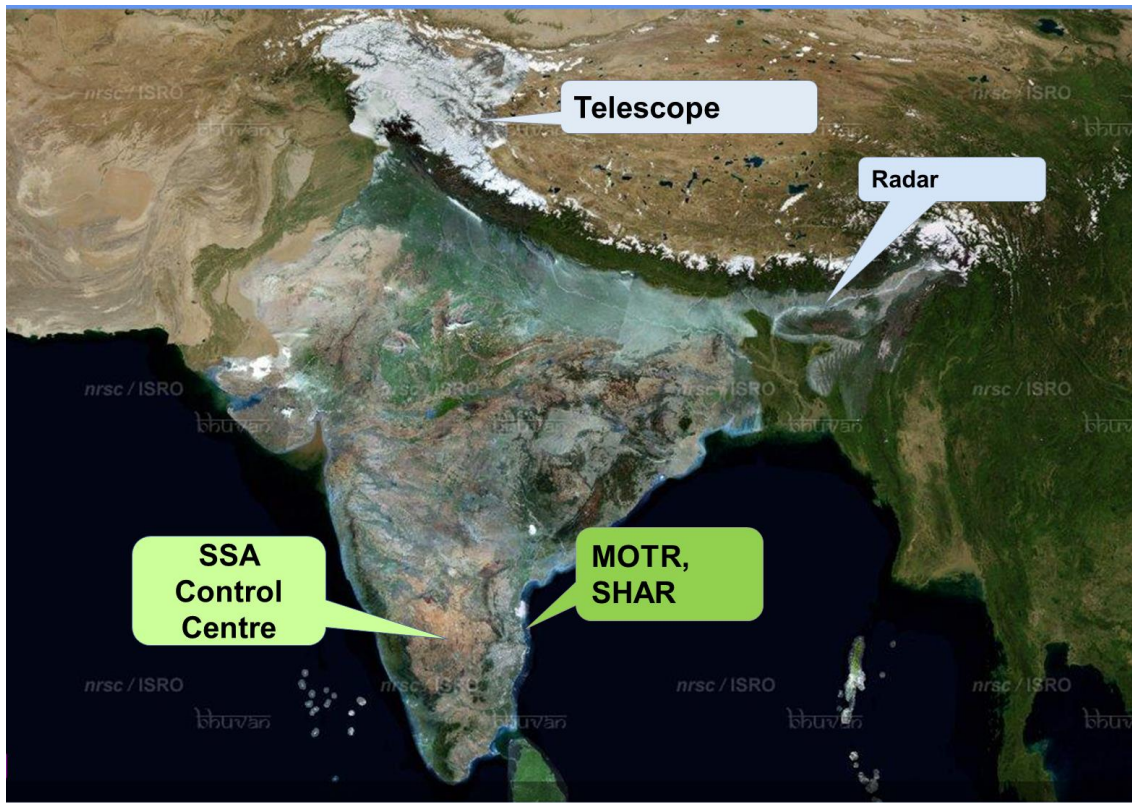
Radar Observation Network for LEO object



Optical Observation Network for GEO object



Control Centre: processing observational data, analyzing space situation, data exchange and collaboration



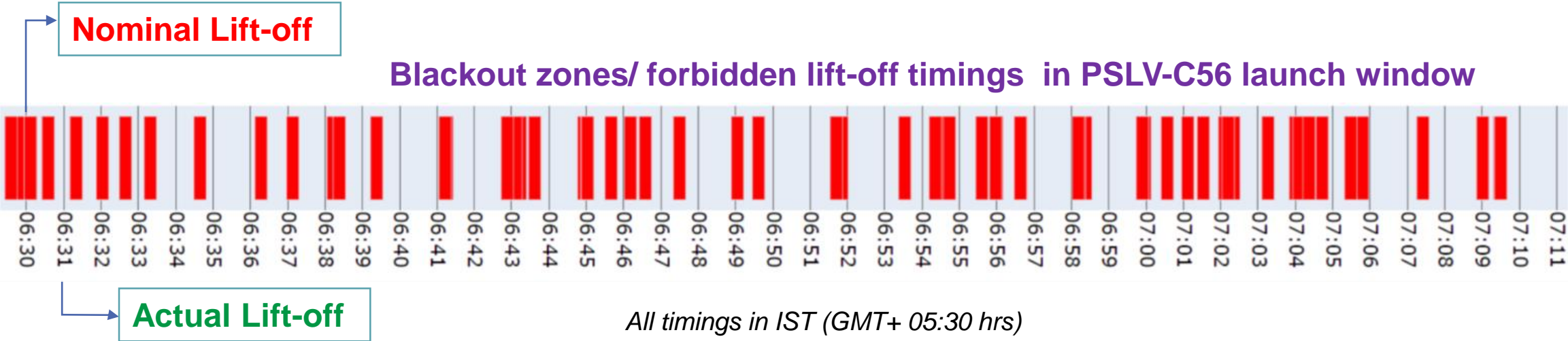
Two more optical telescopes are planned for LEO object and Near Earth Object (NEO) tracking

COLlision Avoidance (COLA) Analysis for Launch Vehicles



- COLA performed for all launches within the reporting period
- Analysis for ascent (and descent, in case of upper stage re-start) phase of orbital stages of LV and initial orbital phase of injected payloads
- Notification to USSPACECOM and coordination with other S/C operators

Mission	Nominal liftoff time (IST)	Delayed by	Actual liftoff time (IST)
LVM3-M4/ Chandrayaan-3	14 Jul 2023, 14:35:13	4 sec	14 Jul 2023, 14:35:17
PSLV-C56/ DS-SAR	30 Jul 2023, 06:30:00	1 min	30 Jul 2023, 06:31:00

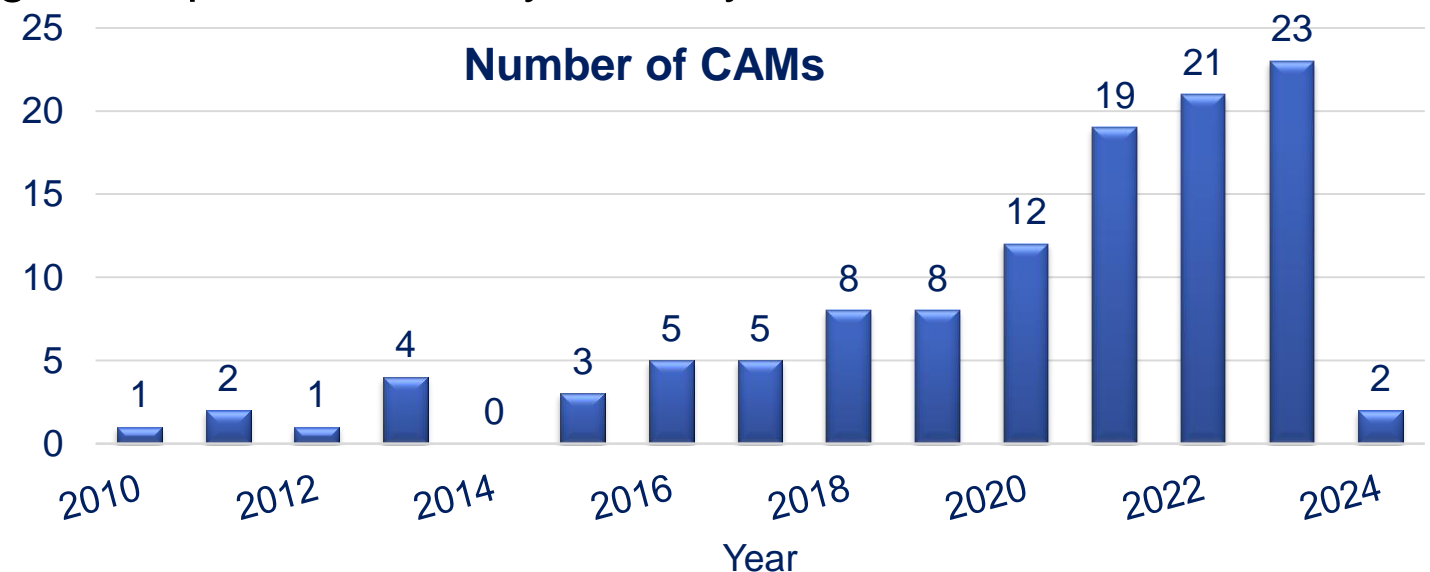


Space Object Proximity Analysis

- For all LEO and GEO satellites, regular conjunction analysis with other space objects.
- Collision avoidance maneuvers (CAM) recommendations based on detailed analysis of close conjunctions and alerts from CSpOC.
- Screening of post-maneuver trajectory of any planned orbit maneuver (OM) including CAM, through SOPA to minimise post-maneuver conjunction risks
 - Out of 494 screenings, plans modified for 115 maneuvers
- In case of close approach with another operational satellites, coordination with respective agency for orbital data and information exchange to improve accuracy of analysis

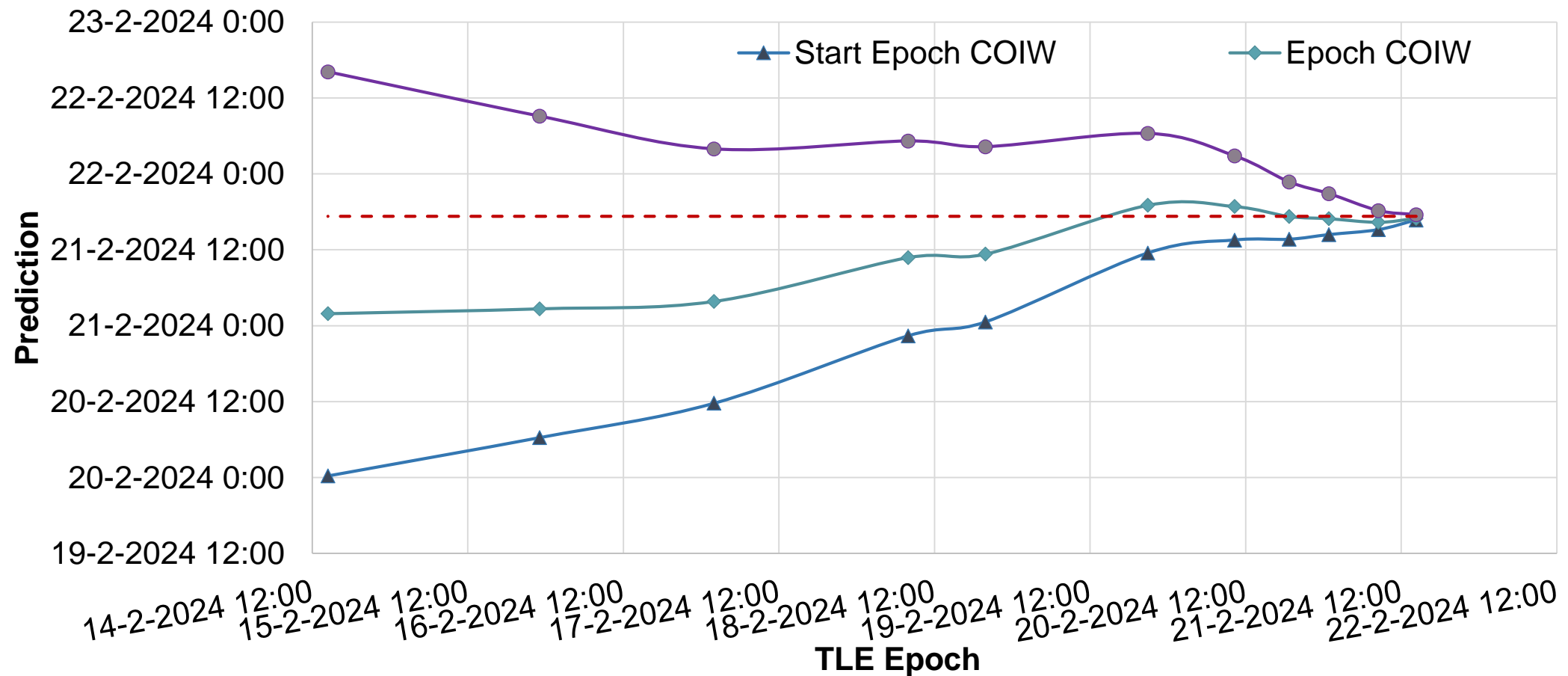
CAMs within reporting period (Jun 2023-Apr 2024)

LEO Satellites	GEO Satellites
9	4



Annual Re-entry Prediction Campaign 2023

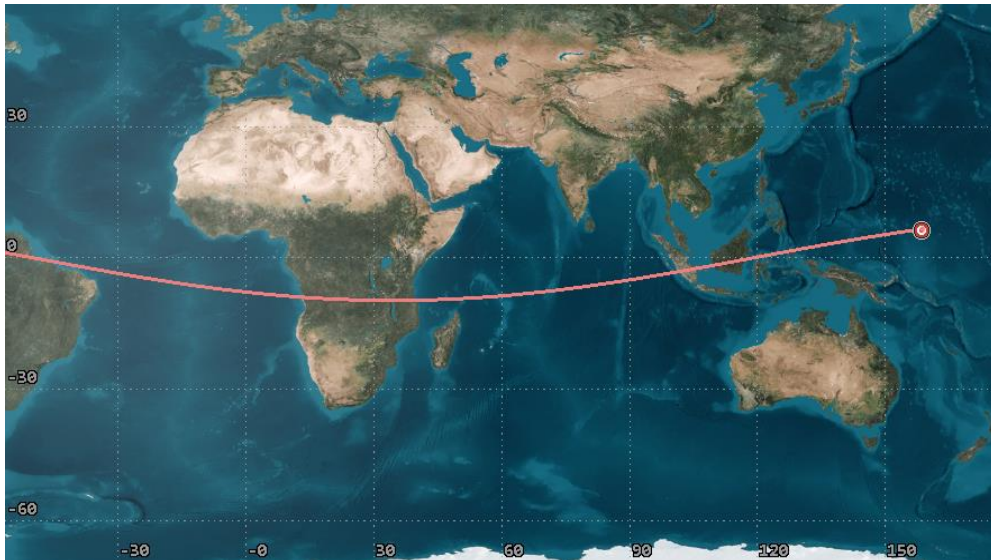
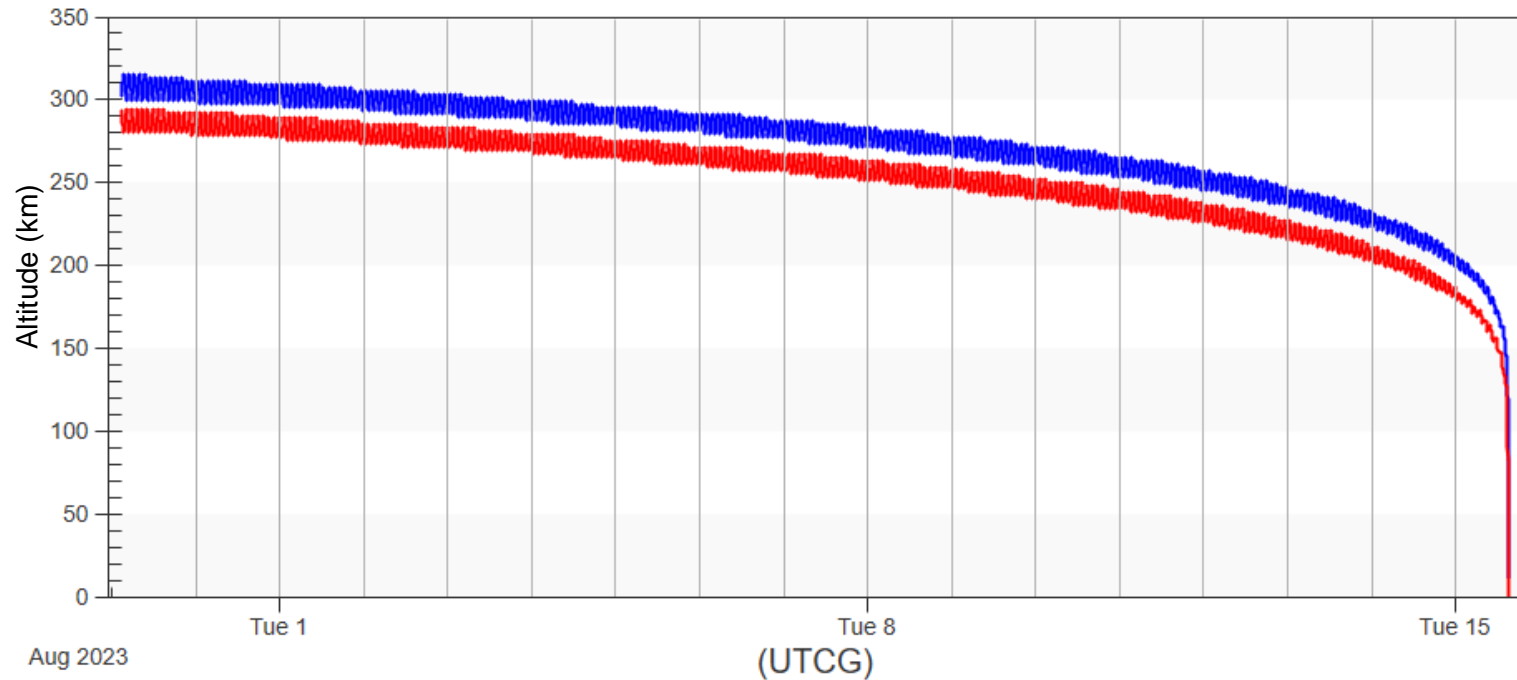
- Test object: ERS-02, campaign duration: 7 Feb-21 Feb, 2024
- ISRO submitted 11 re-entry predictions to IADC website.
- Declared re-entry Epoch: 17:17:00 UTC, 21 Feb 2024
- ISRO's last prediction: 16:59 UTC, 21 Feb 2024



PSLV Upper Stage De-orbiting

PSLV-C56

- Launch: **30 Jul 2023**
- After injection of payloads at 536 km altitude, PS4 deorbited to 300 km by two manoeuvres and passivated
- Atmospheric re-entry within 1 month



PSLV-C58 (POEM*)

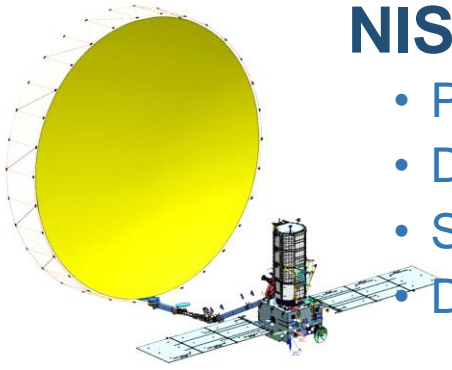
- Launch: **1 Jan 2024**
- After injection Xposat at 650 km, upper stage deorbited to 350 km by two manoeuvres and passivated
- Atmospheric re-entry on **21 March 2024**
- Orbital lifetime reduction to < 3 months

*Also functioned as PSLV Orbital Experimental Module hosting 9 payloads

Shielding to Protect against MMOD Risk

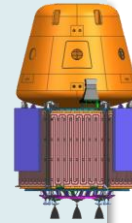
NISAR

- PNP estimation of NISAR using the debris flux data received from JPL-NASA and ORDEM 3.0.
- Design, testing and implementation of stuffed Whipple shield.
- Shield implemented for Battery and Propellant tank.
- Development of light weight Al foam panels and toughened MLI as Debris shield under progress.



Gaganyaan

- Risk assessed for all zones using ESABASE2 software. Debris shields incorporated for zones not meeting PNP specifications.
- Hydrocode simulations conducted to validate Ballistic Limit Equations (BLE). Hypervelocity Impact tests planned at NASA.

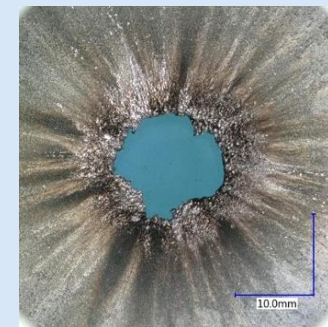


Studies on Shape Effects (AI36.1 – WG3)

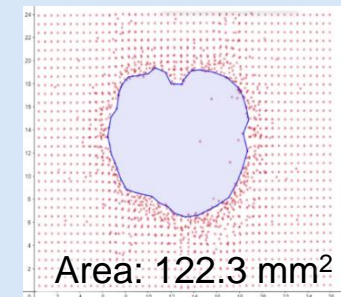
- Hydrocode simulations along with multiparametric space optimization to obtain a BLE for a short cylinder projectile
- Comparison with spherical projectile.

Validation of Benchmark cases (IT41.8 – WG3)

Test cases conducted by NASA with Alumina and Nylon projectiles are validated through Hydrocode simulations.



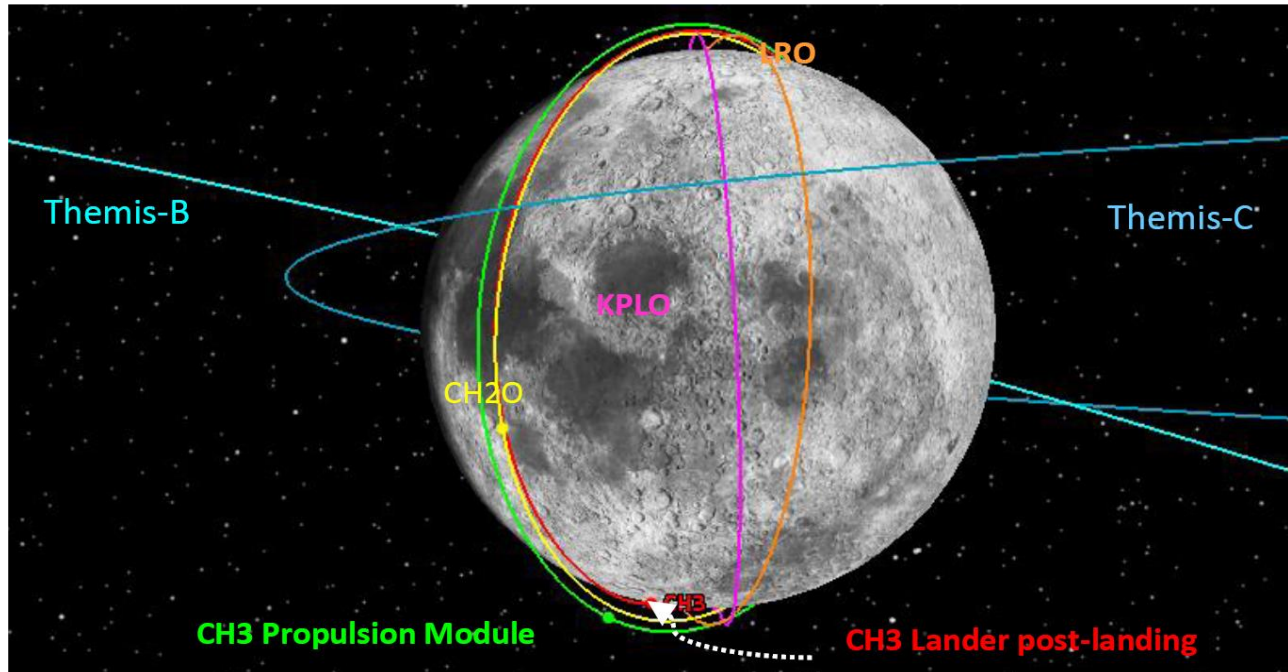
(a) Experiment [NASA]



(b) Simulation [ISRO]

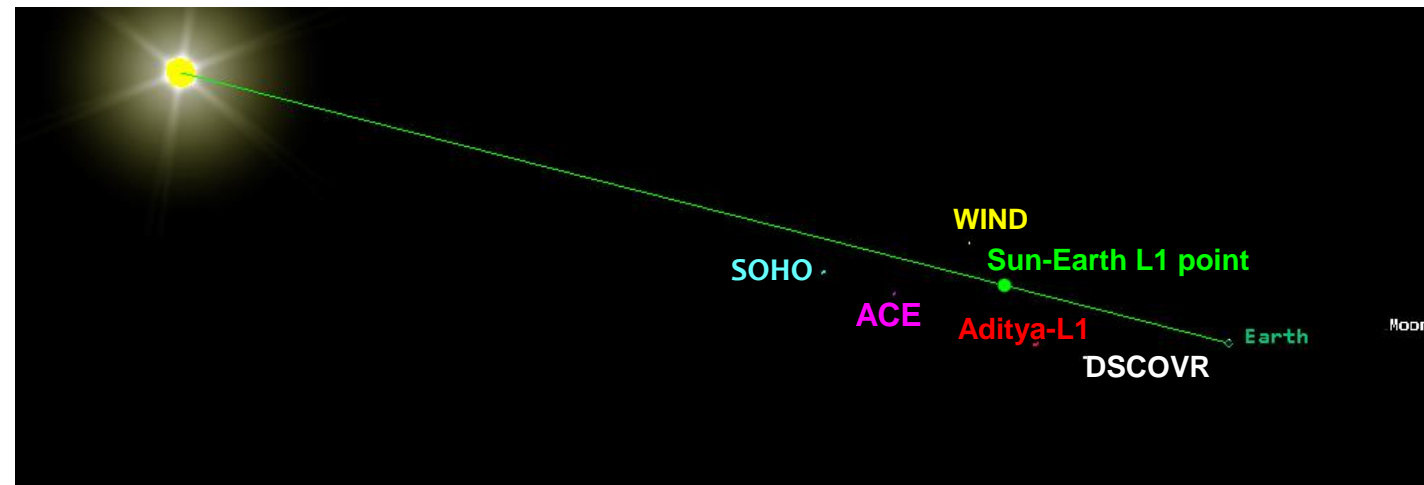
View of rear wall: Impact with Al_2O_3 projectile

Space Debris Mitigation for Deep Space Missions



- Regular analysis for Chandrayaan missions
- Screening of all maneuver plans for Chandrayaan-2 Orbiter (CH2O) and Chandrayaan-3
- Special analysis during SLIM and NOVA-C orbit lowering
- 2 CAMs for CH2O (Jun'23-Apr'24), almost all maneuver plans modified to avoid post maneuver conjunction.
- Chandrayaan-3 propulsion module has been placed in a high-altitude Earth orbit since Nov 2023

- Regular close approach assessment for Aditya-L1 after reaching Sun-Earth L1 point
- Separation with nearest spacecraft more than $1e5$ km



Coordination with External Agencies, Awareness Raising

Coordination with US Space Command (USSPACECOM) and external agencies (NASA, OneWeb, SpaceX, Eumetsat, KARI et al.) for safety of spaceflight

Conjunctions among lunar orbiters resolved through multiple inter-agency deliberations.

Handholding with emergent actors - technical support for SSA activities and SDM implementation

Regular interaction with emergent private operators for authorization and registration through IN-SPACE



Student workshop on SSA and STM in October 2023 with about 200 participants

Thank You