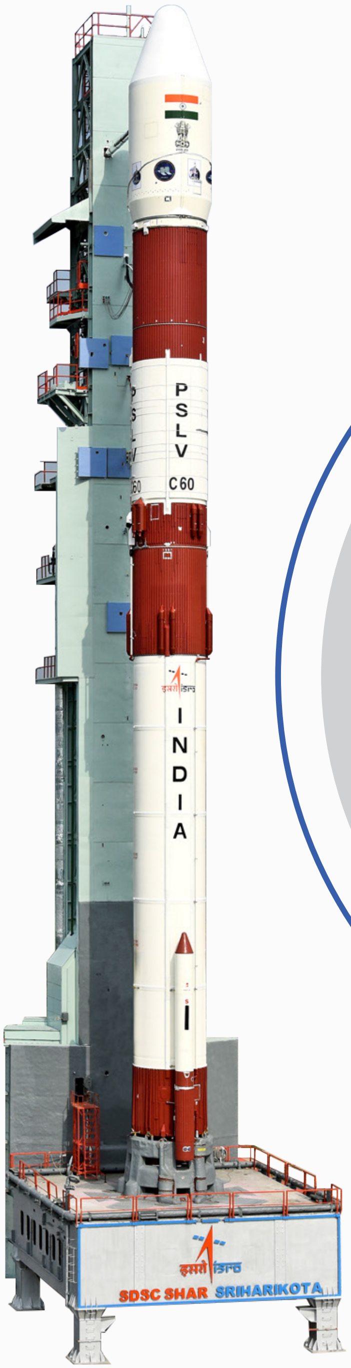
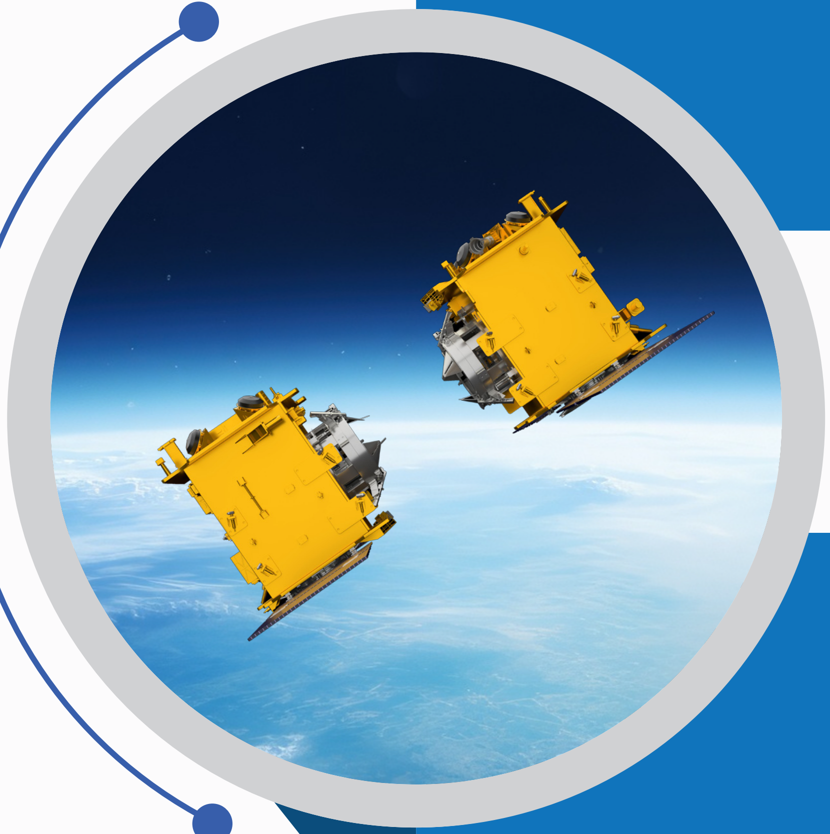
PSLV-C60
SPADEX
Mission





PSLV-C60/SPADEX Mission

PSLV-C60 vehicle will carry a pair of SPADEX satellites into an eastward orbit. Subsequent to SPADEX satellites separation, PS4 stage will be restarted twice to reduce the orbit to 350 km circular orbit with change in inclination/RAAN. The left out propellant in PS4 will be disposed through main engines for enabling safety of PS4 stage. The oxidiser will be let out first followed by fuel in a predetermined sequence of operations. The existing scheme of spent stage passivation by venting the tank pressure will also be active. Post passivation of PS4, the control of stage is transferred to POEM avionics.

PSLV-C60 is the first Vehicle integrated upto PS4 stage at PIF and moved to MST/FLP for Satellites assembly and Launch.

18th Core Alone

62nd PSLV FLIGHT

PSLV-C60 Vehicle Characteristics

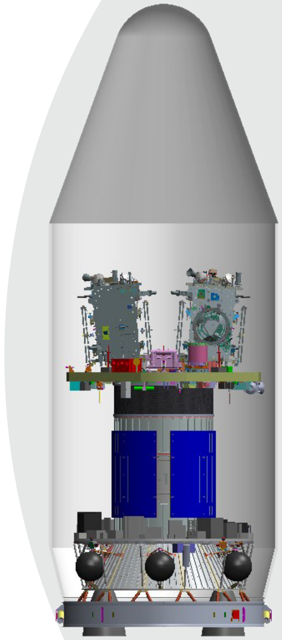
Vehicle Height	44.5 m
Lift off Mass	229 t
Propulsion Stages	
First Stage	S139
Second Stage	PL40
Third Stage	HPS3
Fourth Stage	L1.6 (Ti)

PSLV-C60 Mission Specifications

Osculating Orbital Elements		
Parameter	**Orbit (SPADEX)**	**Orbit (POEM-4)**
Semi-Major Axis (km)	6852.465	6728.137
Eccentricity	0	
Inclination (deg.)	55°	
Launch Pad	FLP	
Launch Azimuth (deg.)	136°	

✓ PSLV-C60 Vehicle Configuration (S139+PL40+HPS3+L1.6 (Ti))

PSLV-C60 Stages at a Glance				
	Stage 1 (PS1)	Stage 2 (PS2)	Stage 3 (HPS3)	Stage 4 (PS4)
Length (m)	20	12.8	3.6	3.0
Diameter (m)	2.8	2.8	2	1.34
Propellant	Solid (HTPB based)	Liquid (UH25 + N_2O_4)	Solid (HTPB based)	Liquid (MMH+ MON3)
Propellant Mass (t)	138	42	7.65	1.6



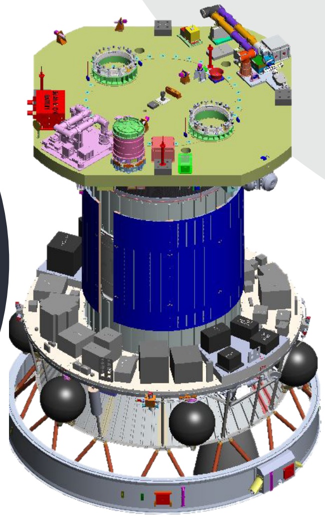
Payload Accommodation in PSLV-C60

✓ Satellites in PSLV-C60

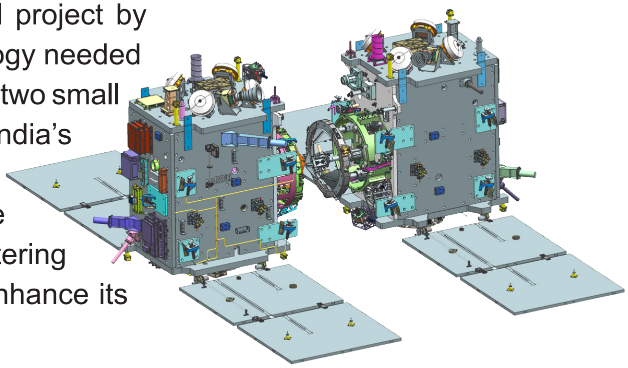
Satellites	Agency	Spacecraft Mass
SPADEX-A	ISRO	~ 220 kg
SPADEX-B	ISRO	~ 220 kg

✓ PSLV Orbital Experimental Module-4 (POEM-4)

PS4 stage is configured as a 3-axis stabilized orbital platform for conducting experiments to space qualify systems with novel ideas. The PS4 stage orbital platform electrical power requirements are catered by flexible solar panel in conjunction with 50Ah Li-Ion battery in battery tied configuration. The orbital platform consists of avionics systems to take care of navigation, guidance, control & tele-commands and orbital platform attitude control system to cater to control of the platform to test the payloads.



SPACE DOCKING EXPERIMENT (SPADEX)

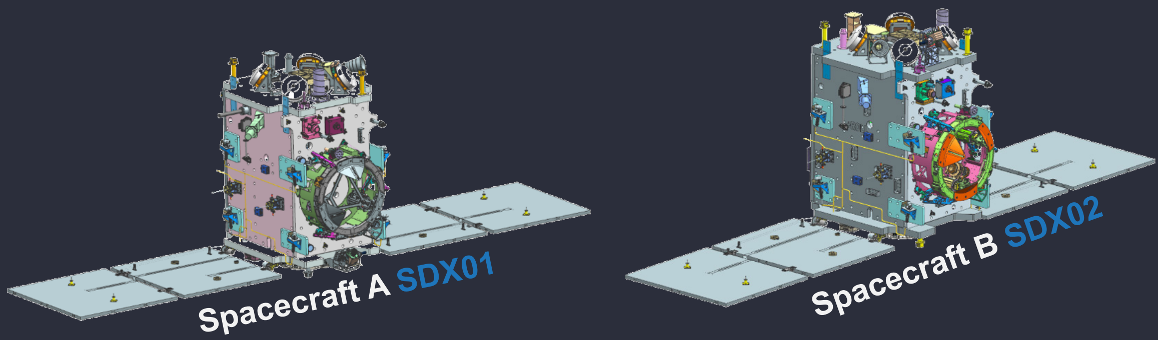


The Space Docking Experiment (SPADEX) is a pivotal project by ISRO designed to develop and demonstrate the technology needed for spacecraft rendezvous, docking, and undocking using two small satellites. SPADEX will serve as a milestone in advancing India's capabilities in space docking, a critical technology for future space missions including satellite servicing, space station operations, and interplanetary missions. By mastering rendezvous and docking technologies, ISRO is set to enhance its operational flexibility and expand its mission horizons.

Mission Objectives

The primary objectives of SPADEX are to develop and demonstrate the technology for rendezvous and docking using two small spacecraft, and to demonstrate controllability in the docked condition, showing the potential for extending the life of the target spacecraft. Additionally, the mission aims to test power transfer between the docked spacecrafts.

The secondary objectives also include post-docking activities where the spacecraft will perform independent payload operations.



SPADEX Spacecrafts

SPADEX spacecrafts named as Spacecraft A and Spacecraft B are built on an extended Microsat Bus, each with a mass of approximately ~220 kg. These spacecrafts are androgynous in nature i.e. either of the spacecraft can act as chaser (active spacecraft) during docking. They are equipped with solar panels, lithium-ion batteries, and a robust power management system. The Attitude and Orbit Control System (AOCS) includes sensors such as star sensors, sun sensors, magnetometers, and actuators like reaction wheels, magnetic torquers, and thrusters.

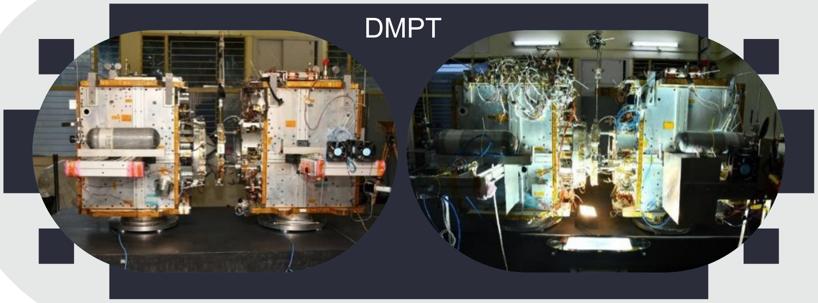
The docking mechanism of SPADEX is motor-driven, featuring capture, extension/retraction, and rigidization mechanisms. There is also a power transfer connector mechanism for experimental power transfer post-docking and a video camera tilt mechanism for monitoring the docking process. The docking procedure is meticulously planned with multiple phases: initial separation and controlled drift, sequentially closer approach phases with hold points for safety and control, and the final docking phase with capture, retraction, and rigidization.

For standalone mission phases after docking experiments, the spacecrafts are equipped with payloads. Spacecraft A is containing with High Resolution Camera (HRC) and Spacecraft B is accommodated with two payloads viz. Miniature Multispectral (MMX) payload & Radiation Monitor (RadMon). These payloads will provide high resolution images, natural resource monitoring, vegetation studies and on-orbit radiation environment measurements which find numerous applications.

Key Technologies

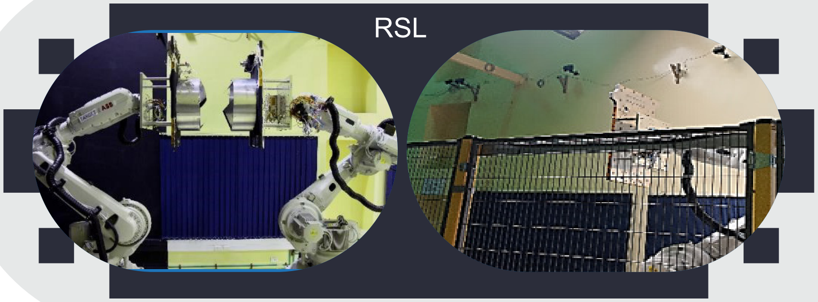
- SPADEX include docking sensors such as the Laser Range Finder (LRF), Rendezvous Sensor (RS), and Proximity & Docking Sensor (PDS) for precise measurement of distance, and attitude.
- Mechanism Entry Sensor (MES) for initiating docking and Video Monitor (VM) for real time imaging of docking operations.
- The spacecrafts are also equipped with Inter Satellite Link (ISL) providing realtime transfer of AOCS and navigation parameters between them for relative state estimation.
- The power system consists of solar arrays generating up to 528 W, supporting continuous load requirements, and power transfer mechanisms to test energy sharing between docked spacecraft.
- The onboard computer (OBC) is a sophisticated system handling command processing, data acquisition, attitude control, telemetry and mechanism motor drives.

SPADEX Special tests



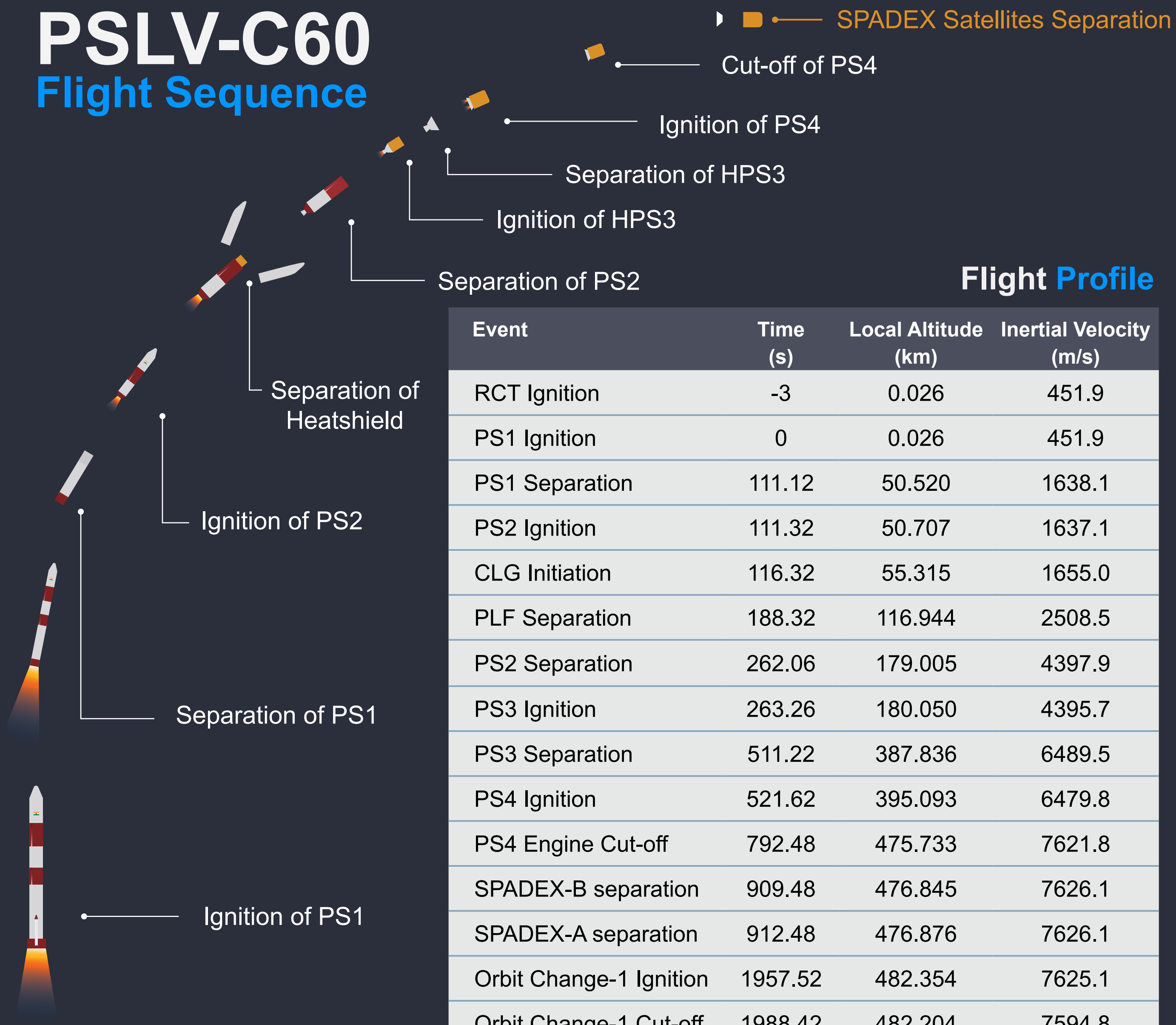
Docking Mechanism Performance Test (DMPT) for testing final phase of Autonomous Rendezvous Docking and Undocking Sequence (ARDUS)

Vertical Docking Experiment Laboratory (VDE) for testing docking mechanisms under controlled conditions



Rendezvous Simulation Lab (RSL) for validating onboard algorithms with real-time simulations. Detailed characterisation tests at sensors level have been carried out in addition to system level tests.

PSLV-C60
Flight Sequence



Flight Profile

Event	Time (s)	Local Altitude (km)	Inertial Velocity (m/s)
RCT Ignition	-3	0.026	451.9
PS1 Ignition	0	0.026	451.9
PS1 Separation	111.12	50.520	1638.1
PS2 Ignition	111.32	50.707	1637.1
CLG Initiation	116.32	55.315	1655.0
PLF Separation	188.32	116.944	2508.5
PS2 Separation	262.06	179.005	4397.9
PS3 Ignition	263.26	180.050	4395.7
PS3 Separation	511.22	387.836	6489.5
PS4 Ignition	521.62	395.093	6479.8
PS4 Engine Cut-off	792.48	475.733	7621.8
SPADEX-B separation	909.48	476.845	7626.1
SPADEX-A separation	912.48	476.876	7626.1
Orbit Change-1 Ignition	1957.52	482.354	7625.1
Orbit Change-1 Cut-off	1988.42	482.204	7594.8
Orbit Change-2 Start	4868.52	365.090	7726.9
Orbit Change-2 Cut-off	4875.54	365.101	7699.1
OP-LMP	5745.54	355.420	7705.0

✓ Payloads in POEM-4

1.Payloads by ISRO (VSSC/ IISU/ IIST)

S. No.	Payload	Objectives
1	Debris capture Robotic Arm	To demonstrate tethered debris capture using • Visual servoing and object motion prediction by robotic arm in space environment • Demonstration of parallel end-effector for object capture and manipulation
2	Lead-Exempt Experimental System (LEXS)	• To realize the package using lead-free components and processes • Assess the reliability & confirm operation in Space environment.
3	MEMS Rate Sensor for LEXS	• Identified Load for LEXS payload • Measure angular rates in 3-axis & Study behaviour of the Sensor in Space
4	CROPS (Compact Research Module for Orbital Plant Studies)	• Multi-phase automated platform to acquire the capability to achieve seed germination. • Plant sustenance till the two leaf stage in microgravity environment.
5	MIRS (Multi Sensor Inertial Reference System)	To demonstrate the performance of Miniaturized inertial Sensors • Hemispherical Resonating Gyroscope(HRG) • Coriolis Resonating Gyro (iCRG-Digital) • Tuning Fork Gyroscopes(TFG) • Advanced Geomagnetic Sensor(AGS)
6	RRM-TD (Relocatable Robotic Manipulator)	To demonstrate re-location through inch-worm walking to designated points with • Vision in loop robotic arm operation for grappling • AI based visual inspection

7	RWA (Reaction wheel Assembly)	To study attitude stabilisation of POEM Platform
8	LFU - Laser Firing Unit LIP - Laser initiated Pyro	Onboard demonstration of Laser Initiated Device (LID) operation using Laser Initiated Pyrothruster (LIP)
9	LP V2 - 3 Nos.	• Measurement of electron density in the orbit • Estimate absolute electron density with three cylindrical LPs
10	ENWi – 2 Nos. (Electron Density and Wind Probe)	Measurement of ion drift in two perpendicular directions along the orbit
11	ETA	• Electron Temp Analyser • Electron density of planetary ionosphere
12	PCOC	Common controller for SPL Payloads
13	PLASDEM (Plasmaspheric Density Measurement)	Measurement of Plasmaspheric Electron Content based on NavIC receiver onboard POEM, primarily over the Indian region (NavIC regional coverage)
14	PILOT-2	To space qualify in house developed • CubeSat UHF Board • Geiger-Muller Counter (GMC) payload measuring radiations • In-Orbit Reprogramming of OBC

2. Payloads by Other Agencies/ Institutions

S. No.	Agencies/ Institutions	Payloads	Objectives
1	GalaxEye Space	GLX-SQ	To validate the functionality and reliability of the hardware and software components essential for the processing and transmission of • Synthetic Aperture Radar (SAR) imagery • Accuracy of the DAC, ADC in space environments
2	SJC Institute of Technology	BGS ARPIT	Multimode message transmitter payload that can transmit audio, text and image messages from a satellite to the ground using FM modulation and VHF band
3	Bellatrix Aerospace	RUDRA 1.0 HPGP	• To demonstrate high Performance Green Propulsion System • Sustained, steady state thruster firing for minimum 50 s. • Monitoring the thermal profile of the Propulsion System
4	RV College of Engineering	RVSat-1	The aim is to perform a microbiological experiment under microgravity conditions in Low Earth Orbit.
5	MIT-WPU	STeRG-P1.0	To test ARM processor based avionics with MEMS sensors for attitude and inertial measurements based on innovative filtering algorithms.

6	PierSight Space	Varuna	• To test X-Band electronics for SAR (Developed using Direct RF Sampling architecture) in space. • Test Base band electronics for Automated Identification Sensor • Test deployment mechanism of reflect-array antenna for SAR in space
7	Manastu Space	VYOM-2U	Monopropellant formulated as a blend of hydrogen peroxide and in house additives, is designed with the aim of providing a safer and higher performing alternative to hydrazine for space applications
8	TakeMe2Space	MOI-TD	• Characterisation of indigenously developed nano-satellite OBC with AI accelerator, reaction wheel, magnetorquers, sun sensor, spectral sensor, camera and flexible GaAs solar cell. • Demonstration of AI-model uplink from ground and on-orbit execution
9	Amity University	APEMS	Study of the growth-related changes of plant callus with a Spinacia oleracea model under microgravity (Space environment) and Earth gravity (Natural environment)
10	N Space Tech	Swetchasat	To establish a communication link to demonstrate the capability of UHF transmitter on board by seeking ground station support from the ISTRAC ground station.

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