PSLV-C25/Mars Orbiter Mission

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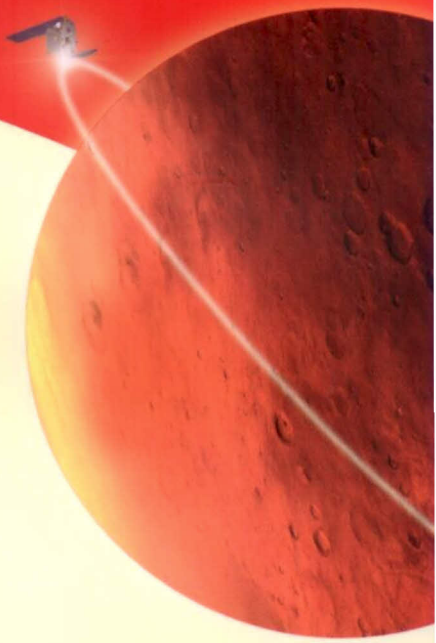


PSLV

PSLV PROJECT

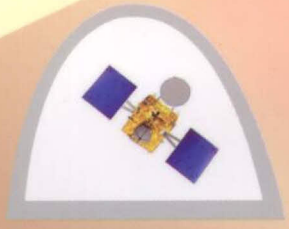
INDIAN SPACE RESEARCH ORGANISATION

25th PSLV Mission

PSLV-XL Missions Heritage

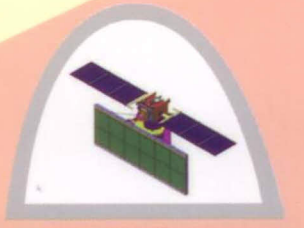
PSLV-C11
CHANDRAYAAN-1 Mission

First Lunar
Mission of India



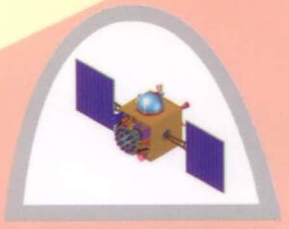
PSLV-C17
GSAT-12 Mission

Dedicated
Communication Satellite



PSLV-C19
RISAT-1 Mission

Heaviest Satellite
ever launched by PSLV



PSLV-C22
IRNSS-1A Mission

First Regional
Navigation Satellite

MISSION	SPACECRAFT	SPACECRAFT MASS	ORBIT	LAUNCH DATE
PSLV-C11	Chandrayaan-1	1380 kg	255 km x 22860 km	22-10-2008
PSLV-C17	GSAT-12	1410 kg	284 km x 21000 km	15-07-2011
PSLV-C19	RISAT-1	1858 kg	480 km (SSPO)	26-04-2012
PSLV-C22	IRNSS-1A	1426 kg	284 km x 20650 km	01-07-2013

PSLV-C25/Mars Orbiter Mission

PSLV-C25, the 25th mission of PSLV and 5th in the XL configuration, will carry the Mars Orbiter Satellite (1337 kg) into a 250 km x 23500 km elliptical orbit. The Satellite will be further navigated to a hyperbolic departure trajectory and thereafter it traverses an interplanetary cruise trajectory before reaching the intended orbit around the Mars.

Challenges.....

The major technical challenges for the Launch Vehicle in accomplishing this Mission arise from the larger Argument of Perigee (AOP) requirement ranging from 276.4° to 288.6° compared to 178° in earlier Missions. This AOP minimises the energy required in transferring the satellite from the Earth to the Mars. In this regard, the Launch Vehicle flight regime is extended to 2657s (against 1200s for regular PSLV Missions) with a long coasting (1580-1800s) before the ignition of the PS4 stage. The long coasting necessitated specific modification and validation of the coast phase guidance algorithm, on-board battery capacity augmentation, assessment on the performance of inertial systems for extended flight duration and deployment of two Ship-borne Terminals to capture the critical telemetry data during flight in the non-visibility zone.

Additional provisions are made for the thermal management of Vehicle Equipment Bay, PS4 stage and also the Spacecraft elements considering the longer exposure to extreme cold space.

Another unique task associated with management of this Mission is the generation and Configuration Control of multiple Initialization files for the on-board computers corresponding to the different launch dates.

PSLV-C25 Vehicle Characteristics

Vehicle Height	44.4 m
Lift off Mass	320 t
Propulsion Stages	
First Stage	6PSOM-XL+S139
Second Stage	PL40
Third Stage	HPS3
Fourth Stage	L2.5
Payload Fairing	3.2 m dia

Mission Specifications

Apogee	23500 ±675 km
Perigee	250 ±5 km
Argument of Perigee	282.55 ± 0.2° (For Launch on 5th November, 2013)
Inclination	19.2 ± 0.2°
Payload Mass	1337 kg

Polar Satellite Launch Vehicle

PSLV-C25 Vehicle Configuration

The Polar Satellite Launch Vehicle (PSLV) caters to the requirements of launching satellites into Sun-Synchronous and Low Earth Orbits. PSLV is a four stage vehicle with alternate Solid and Liquid propulsion stages. The booster stage along with the strap-on motors and the third stage are solid motors while the second and fourth stages use liquid engines.

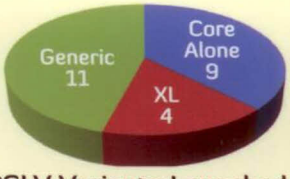
PSLV has the capability to launch 1750 kg class satellites into 600 km Sun-Synchronous Polar Orbit (SSPO) and 1425 kg satellites into Sub-Geosynchronous Transfer Orbit (Sub GTO) of 284 km X 21000 km. The vehicle has provision to launch multiple satellites.

PSLV has successfully accomplished 2 developmental and 21 operational Missions in a row. It has established itself as a work horse operational launcher of ISRO and has a demonstrated reliability of 0.96. Currently two variants of PSLV are operational, namely PSLV-XL (with six extended strap-on motors attached to the first stage) and PSLV-Core Alone (without strap-on motors). PSLV-C25/Mars Orbiter Mission employs the PSLV-XL version which has already been used in four earlier Missions.

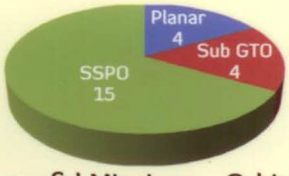
PSLV-XL: Stages at a Glance

	Stage 1	PSOM-XL	Stage 2	Stage 3	Stage 4
Length (m)	20	12	12.8	3.6	2.7
Diameter (m)	2.8	1	2.8	2	2.8
Propellant	Solid (HTPB based)	Soild (HTPB based)	Liquid ($UH25+N_2O_4$)	Solid (HTPB based)	Liquid (MMH+MON3)
Propellant Mass (t)	138	12.2	42	7.6	2.5
Peak Thrust (kN)	4800	719	799	247	7.3x2
Burn Time (s)	103	50	148	112	525

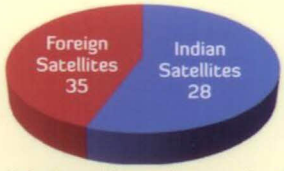
23 Successive Successful Missions Accomplished



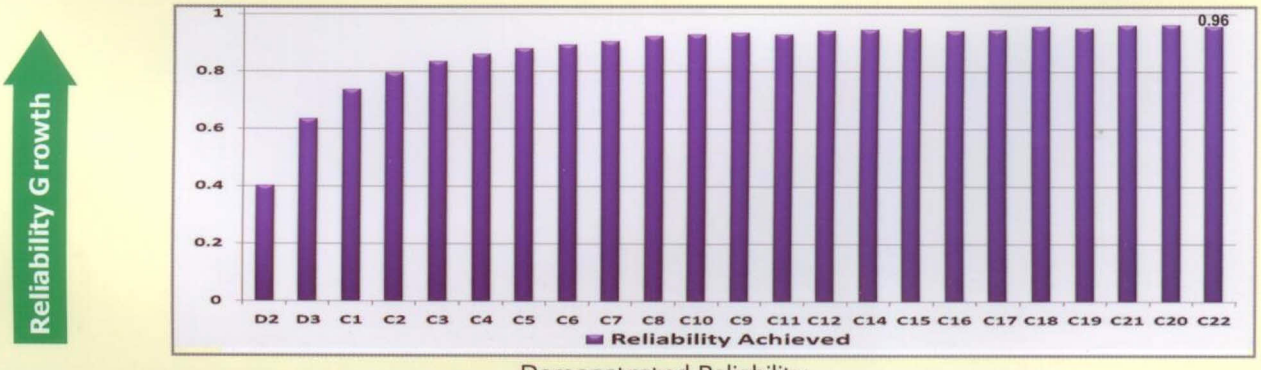
PSLV Variants Launched



Successful Missions - Orbit types

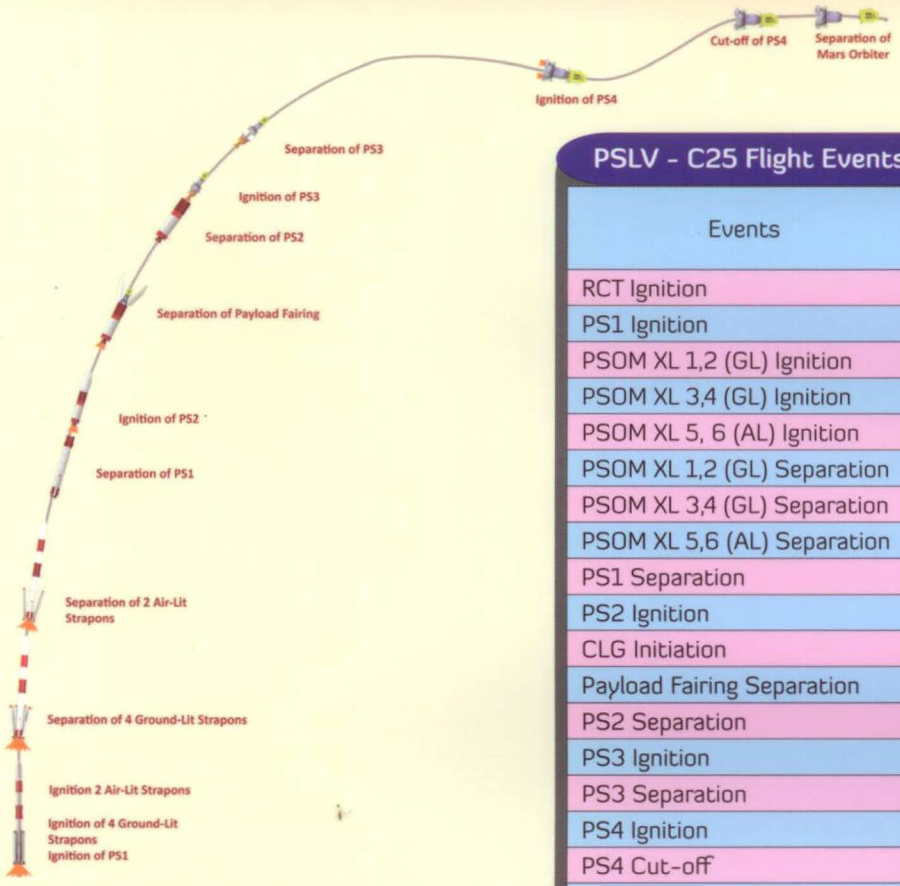


63 Satellites Launched



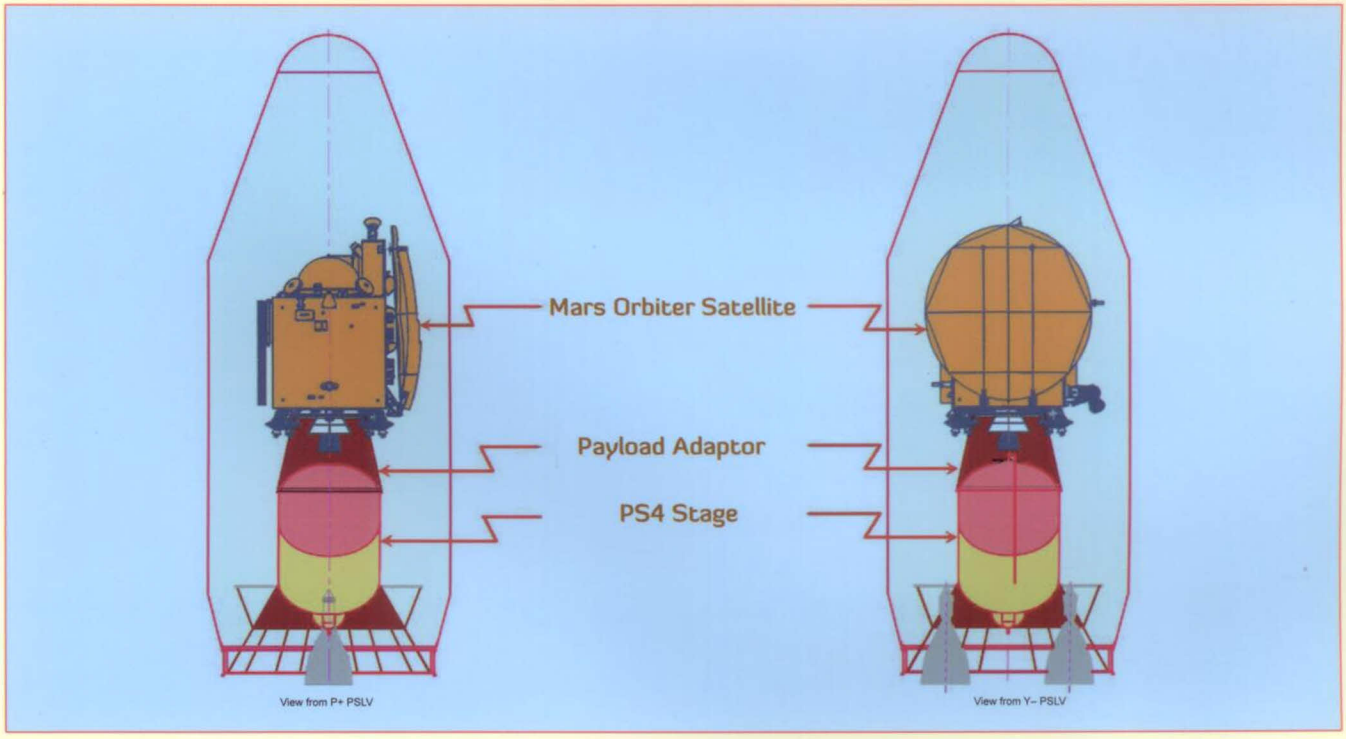
Demonstrated Reliability

PSLV-C25 Flight Sequence



PSLV - C25 Flight Events for Launch on 5th Nov. 2013

Events	Time (s)	Local Altitude (km)	Inertial Velocity (m/s)
RCT Ignition	-3.00	0.024	451.89
PS1 Ignition	0.00	0.024	451.89
PSOM XL 1,2 (GL) Ignition	0.46	0.024	451.89
PSOM XL 3,4 (GL) Ignition	0.66	0.024	451.89
PSOM XL 5, 6 (AL) Ignition	25.04	2.670	611.52
PSOM XL 1,2 (GL) Separation	69.94	23.489	1431.80
PSOM XL 3,4 (GL) Separation	70.14	23.618	1436.54
PSOM XL 5,6 (AL) Separation	92.04	39.704	2024.36
PS1 Separation	112.75	57.678	2387.67
PS2 Ignition	112.95	57.846	2387.16
CLG Initiation	117.95	61.955	2415.46
Payload Fairing Separation	201.75	113.169	3624.69
PS2 Separation	264.74	132.311	5379.33
PS3 Ignition	265.94	132.531	5378.94
PS3 Separation	583.60	194.869	7730.88
PS4 Ignition	2100.50	271.317	7642.04
PS4 Cut-off	2619.72	342.515	9833.49
Mars Orbiter Separation	2656.72	383.388	9804.01



Payload Accommodation in PSLV-C25

Mars Orbiter

Mars Orbiter Mission is ISRO's first Interplanetary Mission with an Orbiter craft designed to orbit Mars in an elliptical orbit of 366 km x 80000 km. The technological objective of the Mission is to design and realize a spacecraft with a capability to perform Earth Bound Manoeuvre, Martian Transfer Trajectory (MTT) and Mars Orbit Insertion (MOI) phases.

Mars Orbiter

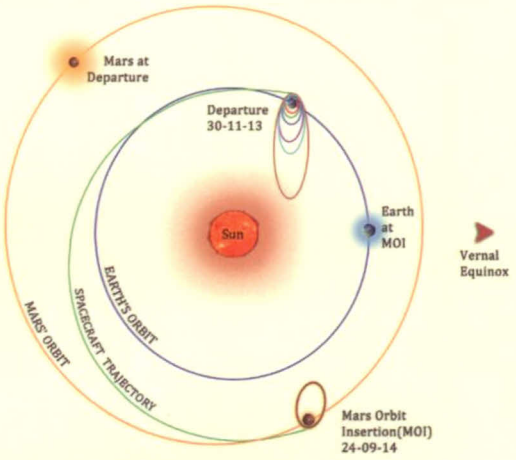
Technological Objectives

- To develop the technologies required for design, planning, management, deep space communication and operations of an Interplanetary Mission.
- To design and realize Mars Orbiter with a capability to survive and perform Earth bound Manoeuvres, cruise phase of 300 days, Mars orbit insertion & captu re, and on-orbit phase around Mars.
- Incorporate autonomous features to handle contingency situations.

Payloads

- Lyman Alpha Photometer (LAP)
- Methane Sensor for Mars (MSM)
- Martian Exospheric Neutral Composition Explorer (MENCA)
- Mars Colour Camera (MCC)
- TIR Imaging Spectrometer (TIS)

The scientific objectives of these payloads are exploration of Mars surface features, morphology, mineralogy and Martian atmosphere.



Trajectory Design

Reaching Mars.....

The Earth-Mars transition comprises the following three phases

- Earth-centered phase
- Heliocentric phase
- Martian phase

The Spacecraft is injected into an elliptical parking orbit by the launcher. After injection of the Mars Orbiter into the orbit, five orbit raising burns using Liquid Engine are planned. After these burns, the Orbiter will be given a Trans-Mars Injection (TMI) manoeuvre at perigee which will put the Spacecraft in the Mars Transfer Trajectory. After the end of the TMI, the Orbiter travels in a hyperbolic departure trajectory with which it escapes from the Earth's Sphere Of Influence (SOI). After crossing the Earth's SOI, the Spacecraft is in an elliptical interplanetary cruise trajectory around the sun for the planned transfer time after which it has its rendezvous with Mars. The spacecraft arrives at the Mars SOI in a hyperbolic trajectory. When the Orbiter reaches Periapsis, closest to Mars, it is manoeuvred for Mars Orbit Insertion (MOI), which will insert the Orbiter into an elliptical Martian orbit of 366 km x 80000 km .

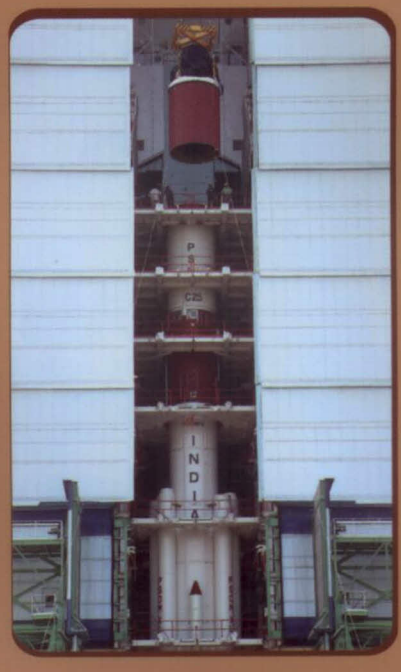
Glimpses of Pre-Launch Operations

CBS+NES Stacking

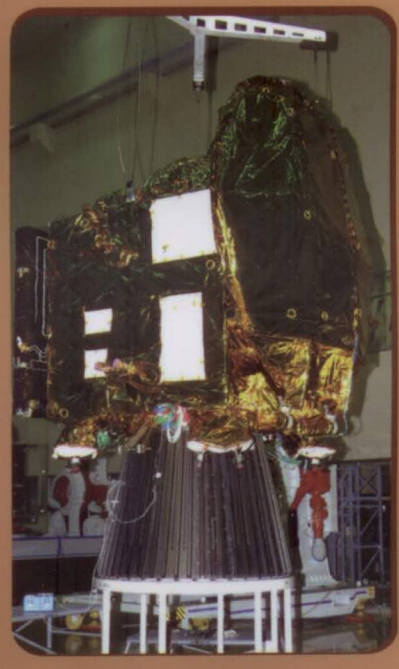
PSOM-XL Assembly

PS2 Stacking

PS3-PS4 Moduling

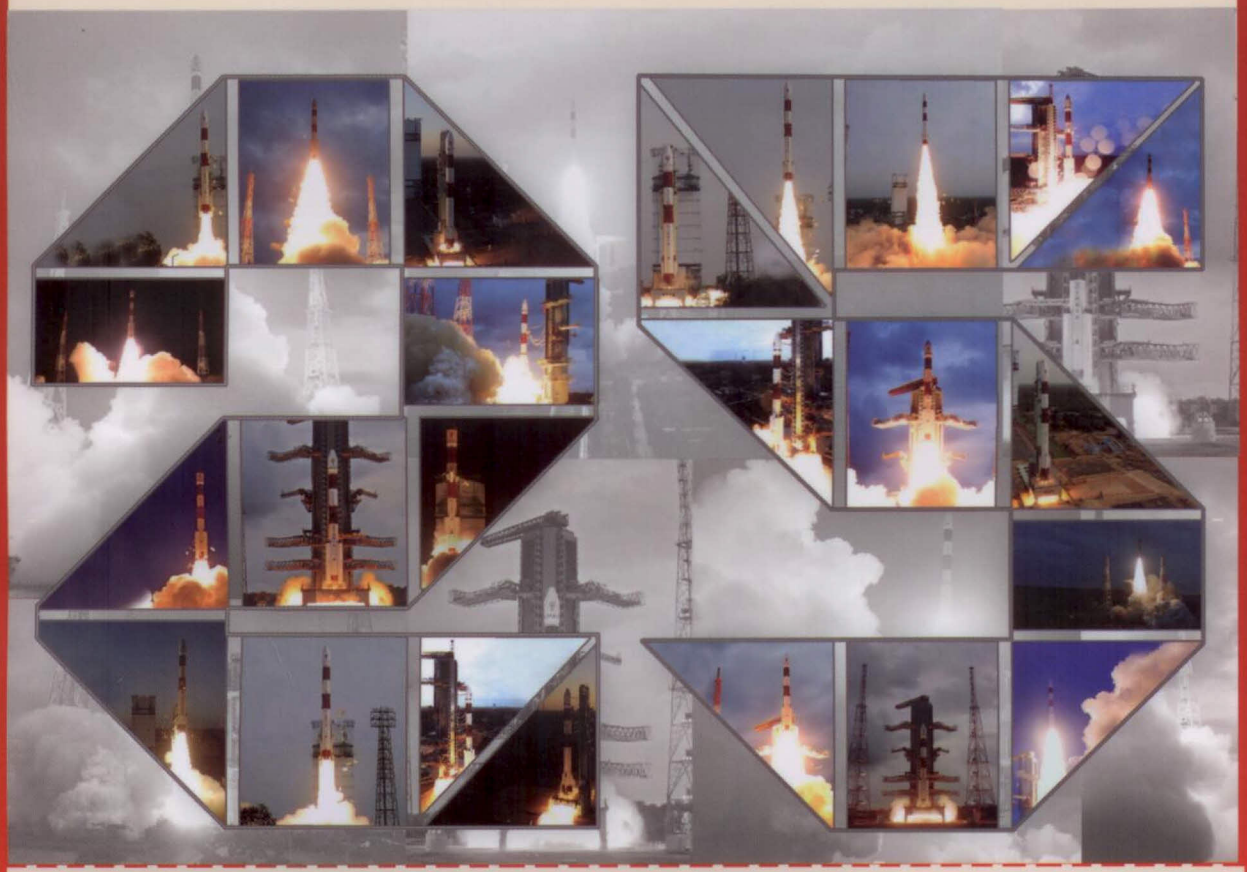


PS3-PS4 Module Stacking



Mars Orbiter Testing

PSLV Launches....



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