PSLV-C30
ASTROSAT

ASTROSAT

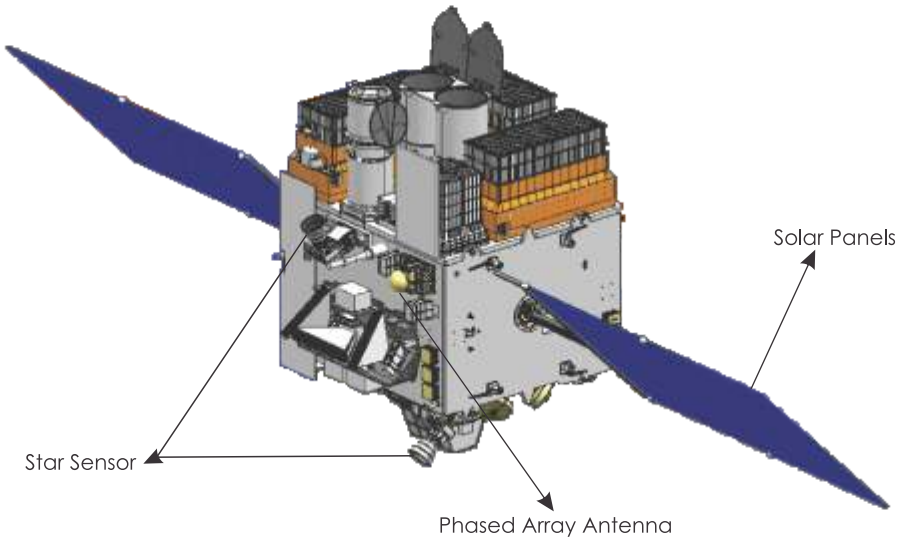
Integration of ASTROSAT in a clean room at ISRO Satellite Centre

ASTROSAT is India's first dedicated multi wavelength space observatory. This scientific satellite mission endeavours for a more detailed understanding of our universe. One of the unique features of ASTROSAT mission is that it enables the simultaneous multi-wavelength observations of various astronomical objects with a single satellite.

ASTROSAT will observe universe in the optical, Ultraviolet, low and high energy X-ray regions of the electromagnetic spectrum, whereas most other scientific satellites are capable of observing a narrow range of wavelength band. Multi-wavelength observations of ASTROSAT can be further extended with co-ordinated observations using other spacecraft and ground based observations. All major astronomy Institutions and some Universities in India will participate in these observations.

ASTROSAT has a lift-off mass of 1513 kg. It will be launched into a 650 km orbit inclined at an angle of 6 deg to the equator by India's Polar Satellite Launch Vehicle (PSLV) during its thirty first mission (PSLV-C30).

ASTROSAT Configuration



The cuboid shaped ASTROSAT has two solar arrays consisting of Triple Junction solar cells that generate 2100 Watts of electrical power. Sun and Star sensors as well as gyroscopes provide orientation reference for the satellite. Special thermal control schemes have been designed and implemented for some of the critical payload elements. The Attitude and Orbit Control System (AOCS) of Astrosat very accurately maintains the satellite's orientation with the help of reaction wheels, magnetic torquers and thrusters.

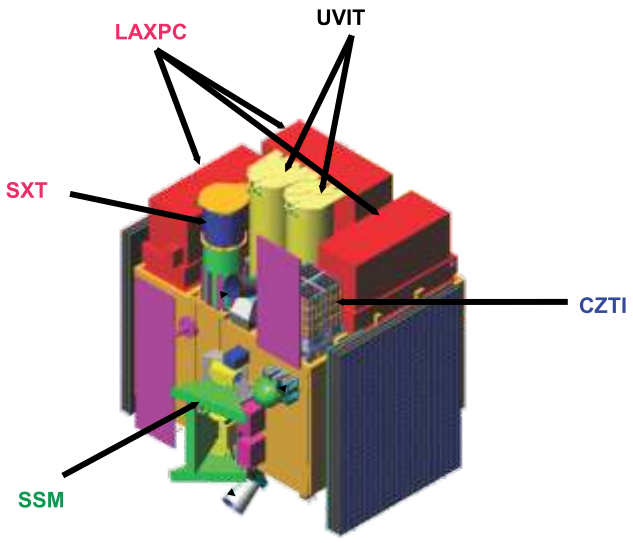
After injection into Orbit, the two solar panels of ASTROSAT are automatically deployed in quick succession and the spacecraft control centre at Mission Operations Complex (MOX) of ISRO Telemetry, Tracking and Command Network (ISTRAC) at Bangalore manages the satellite during its mission life.

The science data gathered by five payloads of ASTROSAT are telemetered to the ground station at MOX. The data is then processed, archieved and distributed by Indian Space Science Data Centre (ISSDC) located at Byalalu, near Bangalore.

ASTROSAT Salient features

ORBIT	650 km Equatorial with 6 deg inclination
LIFT-OFF MASS	1513 kg
DRY MASS	1470 kg
PHYSICAL DIMENSIONS	1.96 metre x 1.75 metre x 1.30 metre
POWER	Two solar arrays generating 2100 W, two Lithium-ion batteries of 36 Ampere-Hour capacity each
PROPULSION	Eight 11 Newton Hydrazine based Monopropellant Thrusters
CONTROL SYSTEM	Zero momentum system, orientation input from Sun & Star Sensors and Gyroscopes; Reaction Wheels, Magnetic Torquers and 11 Newton thrusters as actuators
MISSION LIFE	5 years

ASTROSAT PAYLOADS



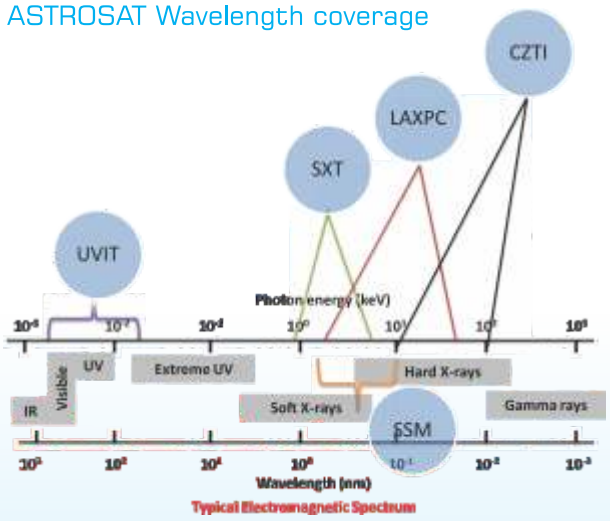
Astrosat Payload Locations

Though most of ISRO satellite missions are applications oriented, the remaining ones are scientific in nature. The first Indian satellite Aryabhata was a scientific satellite. This was followed by such scientific satellite missions like SROSS and Youthsat. Besides, IRS-P3 and GSAT-2 carried onboard piggyback scientific experiments in astronomy. This apart, Chandrayaan-1 and Mars Orbiter Mission, successfully explored the Moon and Mars respectively. ASTROSAT is the next major space science mission of ISRO.

The scientific objectives of ASTROSAT mission are:

- To understand high energy processes in binary star systems containing neutron stars and black holes
- Estimate magnetic fields of neutron stars
- Study star birth regions and high energy processes in star systems lying beyond our galaxy
- Detect new briefly bright X-ray sources in the sky
- Perform a limited deep field survey of the Universe in the Ultraviolet region

ASTROSAT Wavelength coverage



ASTROSAT's five payloads are chosen to facilitate a deeper insight into the various astrophysical processes occurring in the various types of astronomical objects constituting our universe. These payloads rely on the visible, Ultraviolet and X-rays coming from distant celestial sources.

Of the five scientific payloads of ASTROSAT, the **Ultraviolet Imaging Telescope (UVIT)** is jointly developed by Indian Institute of Astrophysics (IIA) at Bangalore and Inter University Centre for Astronomy and Astrophysics (IUCAA) at Pune in collaboration with ISRO and the Canadian Space Agency. This instrument is capable of observing the sky in the visible, near Ultraviolet and far Ultraviolet regions of the electromagnetic spectrum. The two telescopes of the UVIT payload are designed to achieve an excellent image resolution and they also have a large field of view.

Large Area X-ray Proportional Counter (LAXPC), the second payload of ASTROSAT, is designed to study the variations in the emission of X-rays from sources like X-ray binaries, Active Galactic Nuclei and other cosmic sources. It can make measurements of spectral characteristics of different classes of X-ray sources over a wide spectral range of 3-80 kilo electron Volts (keV). LAXPC has nearly five times more effective area for collecting X-ray photons with energy beyond 25 keV compared to other similar scientific satellite mission. Tata Institute of Fundamental Research (TIFR) of Mumbai and Raman Research Institute (RRI) of Bangalore have developed this payload.

ASTROSAT PAYLOADS

Soft X-ray Telescope (SXT) payload of ASTROSAT developed by TIFR in collaboration with the University of Leicester, UK and ISRO, is designed for studying how the X-ray spectrum of 0.3-8 keV range coming from distant celestrial bodies varies with time. Such studies help in understanding the characteristics of the bodies which emitted this particular types of X-rays. This payload has a 2 metre focal length telescope with thin conical foil Gold coated Aluminium foil mirrors for reflecting the X-rays that are incident at a very shallow angle. The focal plane camera of this instrument has a cooled Charge Coupled Device.

Cadmium Zinc Telluride Imager (CZTI), yet another ASTROSAT payload functioning in the X-ray region, extends the capability of the satellite to sense X-rays of high energy in 10-100 keV range. Thus, apart from supplementing the spectral studies afforded by the LAXPC, CZTI payload may also be able to detect gamma ray bursts and study their characteristics. CZTI payload was developed by TIFR and IUCAA in collaboration with ISRO.

The fifth payload of ASTROSAT is the **Scanning Sky Monitor (SSM)**, developed by ISRO Satellite Centre at Bangalore and IUCAA. This instrument is intended to scan the sky for long term monitoring of bright X-ray sources in binary stars, and for the detection and location of sources that become bright in X-rays for a short duration of time. Such transient sources of X-rays will then be studied in detail by other instruments on ASTROSAT.

ASTROSAT was realised with the participation of all major astronomy institutions and some of the Universities in India. It is the first satellite mission to be operated in India as a space observatory. The challenges faced during the development of ASTROSAT include the realisation of a high resolution UVIT including its special coating materials, optical elements, ensuring stringent contamination control for that payload, development of indigenous thin foil and gold coated Aluminium X-ray optics in SXT, high pressure counters of LAXPC, critical thermal control design for all the payloads and special software essential for data flow and satellite operations.

ASTROSAT PAYLOADS

Payload	Energy range	Description	Angular resolution	sensitivity
SXT	0.3 – 8 keV	X-ray foil mirror + CCD FOV=42'	3 – 4 arcmin	~0.01milliCrab (10,000 sec)
LAXPC	3 – 80 keV	Large proportional counters (3)	~5arcmin (scan mode)	0.1 milliCrab (1000 sec)
CZT-imager	10 – 100 keV	CZT array (hard X-ray imager)	8 arcmin	0.5 milliCrab (10,000 sec)
SSM	2.5 – 10 keV	Sky monitors (3) on a boom	5 – 10 arcmin	30 milliCrab (600 sec)
UVIT	1300 – 6500 Ang	Twin RC telescopes – 40 cm each (NUV,VIS, FUV)	1.8 arc sec	20 magnitude (200 sec)

PSLV-C30

PSLV-C30 at First Launch Pad

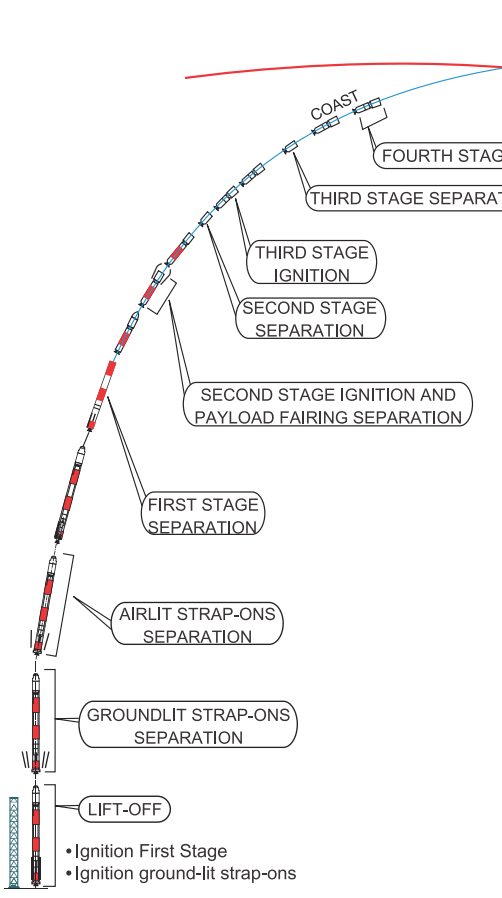
India's Polar Satellite Launch Vehicle, in its thirty first flight (PSLV-C30), is scheduled to launch 1513 kg ASTROSAT into a 650 km orbit of 6 deg inclination to the equator. Along with ASTROSAT, six satellites from international customers viz., 76 kg LAPAN-A2 of Indonesia, 14 kg NLS-14 (Ev9) of Canada and four identical LEMUR satellites of USA together weighing about 28 kg – will be launched in this PSLV flight. PSLV-C30 will be launched from First Launch Pad of Satish Dhawan Space Centre SHAR, Sriharikota. PSLV-C30 is the tenth flight of PSLV in its 'XL' Configuration. The earlier nine flights of PSLV-XL were PSLV-C11/Chandrayaan-1, PSLV-C17/GSAT-12, PSLV-C19/RISAT-1, PSLV-C22/IRNSS-1A, PSLV-C25/Mars Orbiter Spacecraft, PSLV-C24/IRNSS-1B and PSLV-C26/IRNSS-1C, PSLV-C27/IRNSS-1D, PSLV-C28/DMC3 missions. The total payload weight of PSLV-C30 is 1631 kg.

PSLV-C30 at a glance (Vehicle lift-off mass: 320.2 tonne Height: 44.4 m)

	Stage-1	Stage-2	Stage-3	Stage-4
Nomenclature	Core Stage PS1 + 6 Strap-on Motors	PS2	PS3	PS4
Propellant	Solid (HTPB based)	Liquid (UH25 + N_2O_4)	Solid (HTPB based)	Liquid (MMH + MON-3)
Propellant Mass(T)	138.2 (Core), 6 x 12.2 (Strap-on)	41.35	7.6	1.6
Stage Dia (m)	2.8 (Core), 1 (Strap-on)	2.8	2.0	1.34
Stage Length (m)	20 (Core), 12 (Strap-on)	12.8	3.6	3.0

HTPB : Hydroxyl Terminated Poly Butadiene, UH25 : Unsymmetrical Dimethyl Hydrazine + 25% Hydrazine Hydrate
N_2O_4 : Nitrogen Tetroxide, MMH : Mono Methyl Hydrazine, MON-3: Mixed Oxides of Nitrogen

PSLV-C30



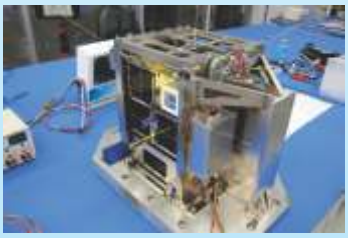
Event	Time (S)	Local Attitude (km)	Internal Velocity (m/s)
LEMUR-4 separation	25min 32.92 sec	649.97	7531.20
LEMUR-3 separation	25min 12.92 sec	650.00	7531.15
LEMUR-2 separation	24min 02.92 sec	650.06	7531.08
LEMUR-1 separation	24min 02.92 sec	650.11	7531.03
NLS-14 separation	23min 27.92 sec	650.14	7530.98
LAPAN–A2 Separation	23min 02.92 sec	650.16	7530.95
ASTROSAT Separation	22min 32.92 sec	650.17	7530.94
Fourth Stage Cut-off (Injection)	21min 55.92 sec	650.17	7528.89
Fourth Stage Ignition	16min 57 sec	583.67	7258.15
Third Stage Separation	9min 47.64 sec	335.54	7544.63
Third Stage Ignition	4min 24.18 sec	157.90	5289.62
Second Stage Separation	4min 22.99 sec	157.76	5289.89
Payload Fairing Separation	2min 49.2 sec	113.97	2982.91
Second Stage Ignition	1min 52.2 sec	64.36	2337.51
First Stage Separation	1min 52 sec	64.16	2338.15
Strap-on 5, 6 (Groundlit) Separation	1min 32.0 sec	43.73	2028.58
Strap-on 3, 4 (Groundlit) Separation	1min 10.1 sec	25.40	1421.08
Strap-on 1, 2 (Groundlit) Separation	1min 9.90 sec	25.25	1416.29
Strap-on 5,6 (Airlit) Ignition	25.0 sec	2.75	604.69
Strap-on 3,4 (Groundlit) Ignition	0.62 sec	0.024	451.89
Strap-on 1,2 (Groundlit) Ignition	0.42 sec	0.024	451.89
First Stage Ignition	0.00	0.024	451.89

PSLV-C30 Typical Flight Profile

International Customer Satellites of PSLV-C30

LAPAN-A2 is a Microsatellite from National Institute of Aeronautics and Space-LAPAN, Indonesia. LAPAN-A2 is meant for providing maritime surveillance using Automatic Identification System (AIS), supporting Indonesian radio amateur communities for disaster mitigation and carrying out Earth surveillance using video and digital camera.

NLS-14 (Ev9), a Nanosatellite from Space Flight Laboratory, University of Toronto Institute for Advanced Studies (SFL, UTIAS), Canada. It is a maritime monitoring Nanosatellite using the next generation Automatic Identification System (AIS).



Four LEMUR nano satellites from Spire Global, Inc. (San Francisco, CA), USA, are non-visual remote sensing satellites, focusing primarily on global maritime intelligence through vessel tracking via the Automatic Identification System (AIS), and high fidelity weather forecasting using GPS Radio Occultation technology.

Satellites of other countries launched by PSLV

SL. NO.	NAME	COUNTRY	DATE OF LAUNCH	MASS (kg)	LAUNCH VEHICLE
1	DLR-TUBSAT	GERMANY	26-05-1999	45	PSLV-C2
2	KITSAT-3	REPUBLIC OF KOREA	26-05-1999	110	PSLV-C2
3	BIRD	GERMANY	22-10-2001	92	PSLV-C3
4	PROBA	BELGIUM	22-10-2001	94	PSLV-C3
5	LAPAN-TUBSAT	INDONESIA	10-01-2007	56	PSLV-C7
6	PEHUENSAT-1	ARGENTINA	10-01-2007	6	PSLV-C7
7	AGILE	ITALY	23-04-2007	350	PSLV-C8
8	TECSAR	ISRAEL	21-01-2008	300	PSLV-C10
9	CAN-X2	CANADA	28-04-2008	7	PSLV-C9
10	CUTE-1.7	JAPAN	28-04-2008	5	PSLV-C9
11	DELFI-C3	THE NETHERLANDS	28-04-2008	6.5	PSLV-C9
12	AAUSAT-II	DENMARK	28-04-2008	3	PSLV-C9
13	COMPASS-I	GERMANY	28-04-2008	3	PSLV-C9
14	SEEDS	JAPAN	28-04-2008	3	PSLV-C9
15	NLS5	CANADA	28-04-2008	16	PSLV-C9
16	RUBIN-8	GERMANY	28-04-2008	8	PSLV-C9
17	CUBESAT-1	GERMANY	23-09-2009	1	PSLV-C14
18	CUBESAT-2	GERMANY	23-09-2009	1	PSLV-C14
19	CUBESAT-3	TURKEY	23-09-2009	1	PSLV-C14
20	CUBESAT-4	SWITZERLAND	23-09-2009	1	PSLV-C14
21	RUBIN-9.1	GERMANY	23-09-2009	1	PSLV-C14
22	RUBIN-9.2	GERMANY	23-09-2009	1	PSLV-C14
23	ALSAT-2A	ALGERIA	12-07-2010	116	PSLV-C15
24	NLS6.1 AISSAT-1	CANADA	12-07-2010	6.5	PSLV-C15
25	NLS6.2 TISAT-1	SWITZERLAND	12-07-2010	1	PSLV-C15
26	X-SAT	SINGAPORE	20-04-2011	106	PSLV-C16
27	VesselSat-1	LUXEMBOURG	12-10-2011	28.7	PSLV-C18
28	SPOT-6	FRANCE	09-09-2012	712	PSLV-C21
29	PROITERES	JAPAN	09-09-2012	15	PSLV-C21
30	SAPPHIRE	CANADA	25-02-2013	148	PSLV-C20
31	NEOSSAT	CANADA	25-02-2013	74	PSLV-C20
32	NLS8.1	AUSTRIA	25-02-2013	14	PSLV-C20
33	NLS8.2	AUSTRIA	25-02-2013	14	PSLV-C20
34	NLS8.3	DENMARK	25-02-2013	3	PSLV-C20
35	STRAND-1	UNITED KINGDOM	25-02-2013	6.5	PSLV-C20
36	SPOT-7	FRANCE	30-06-2014	714	PSLV-C23
37	AISAT	GERMANY	30-06-2014	14	PSLV-C23
38	NLS7.1(CAN-X4)	CANADA	30-06-2014	15	PSLV-C23
39	NLS7.2(CAN-X5)	CANADA	30-06-2014	15	PSLV-C23
40	VELOX-1	SINGAPORE	30-06-2014	7	PSLV-C23
41	DMC3-1	UNITED KINGDOM	10-07-2015	447	PSLV-C28
42	DMC3-2	UNITED KINGDOM	10-07-2015	447	PSLV-C28
43	DMC3-3	UNITED KINGDOM	10-07-2015	447	PSLV-C28
44	CBNT-1	UNITED KINGDOM	10-07-2015	91	PSLV-C28
45	De-OrbitSail	UNITED KINGDOM	10-07-2015	7	PSLV-C28

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www.isro.gov.in

Antrix Corporation Limited
Antrix Corporate Office
Antariksh Bhavan, Near New BEL Road
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