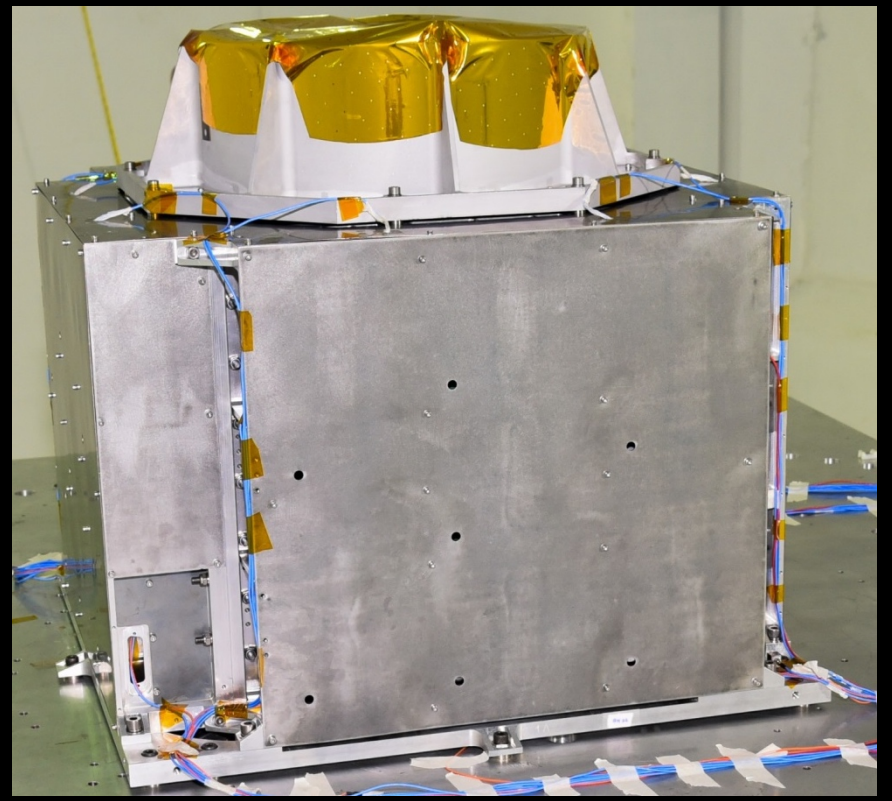
Indian Astronomy and Solar Exploration: XPoSat and Aditya-L1

X-ray **Po**larimeter **Sat**ellite (**XPoSat**)

- Launched on Jan 1, 2024; Space based Indian astronomy mission
- Payloads: **Pol**arimeter **I**nstrument in **X**-rays (**POLIX**) and **X-ray Spectroscopy** & **Timing** (**XSpec**T).
- **Science Objective:** To provide polarization information in medium energy X-rays (8-30 keV) and long term spectral & timing studies in soft X-ray band (0.8-15 keV) for bright X-ray sources.

POLIX Payload

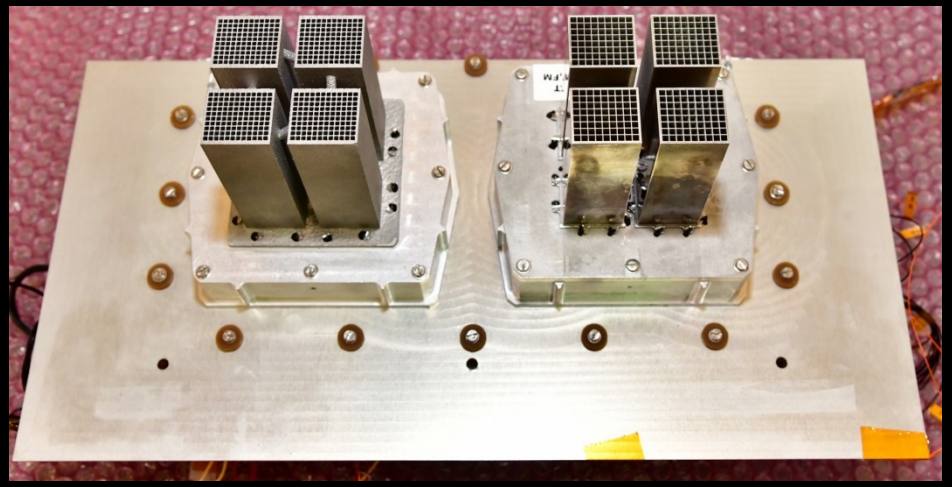
1. POLIX (Polarimeter Instrument in X-rays)
   - To measure polarization (degree and direction) of X-ray photons from celestial sources of interest in the energy band of 8-30 keV.
   - About 50 celestial X-ray sources to be observed during the mission life of 5 years.

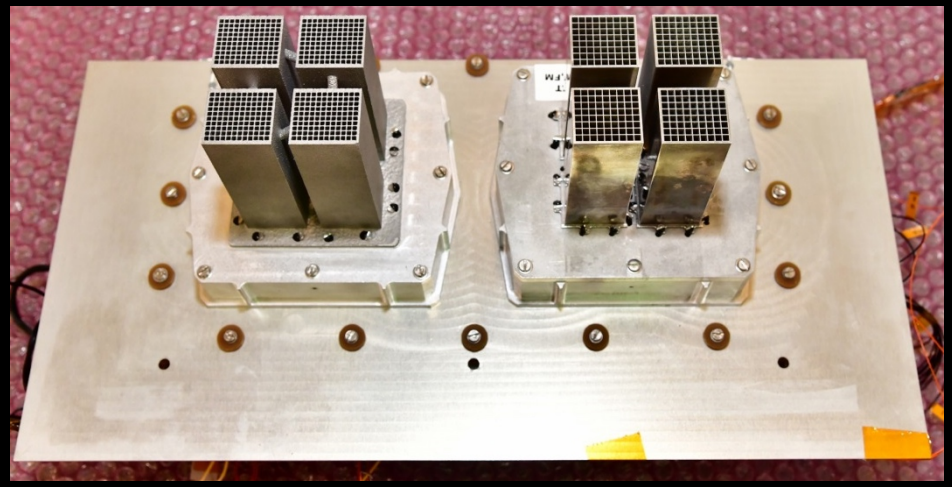


XSPECT Payload

2. XSPECT Payload

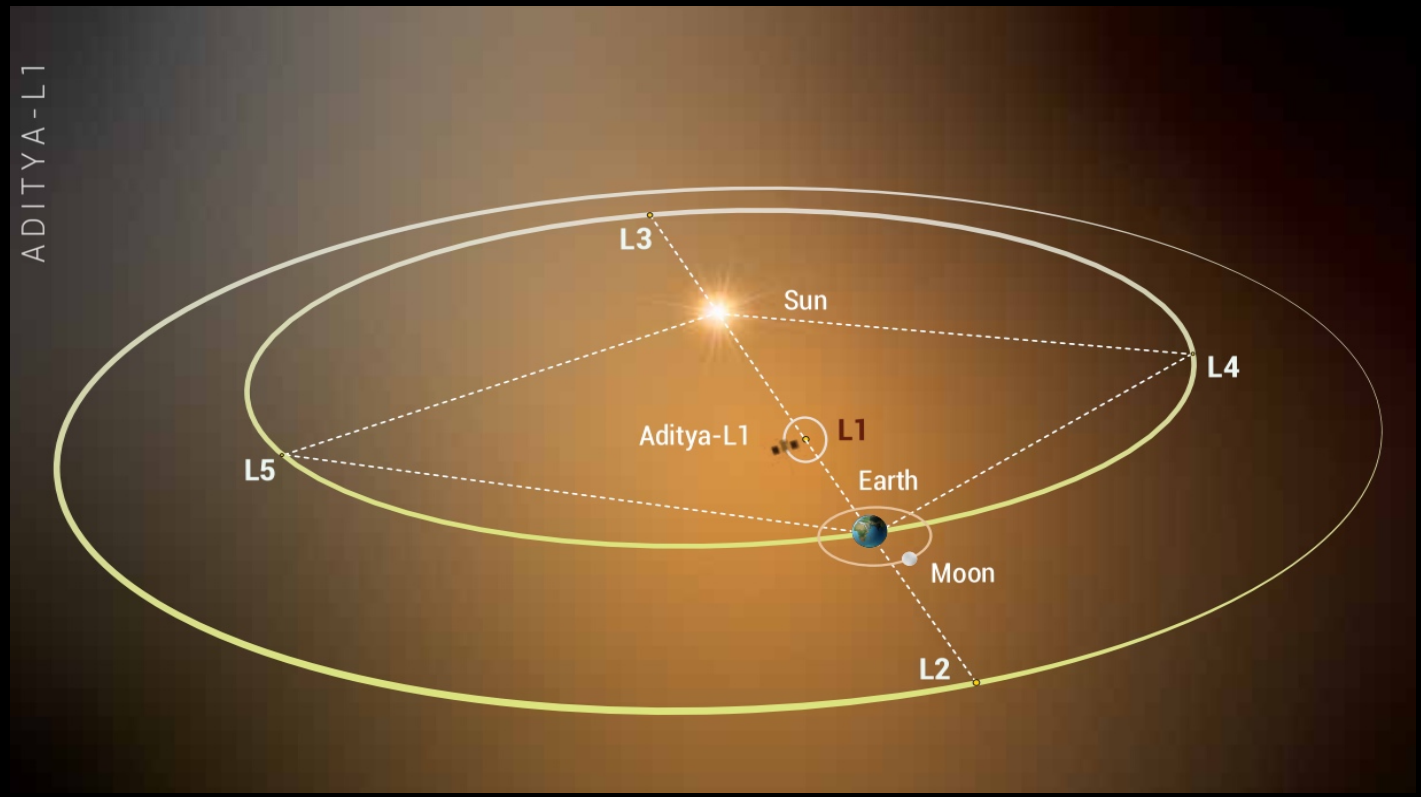
- A soft X-ray spectrometer aimed for studying long term spectral and timing properties of bright X-ray sources in soft energy band (0.8-15keV).
- The spectroscopy measurements along with polarization information can give further insight into radiative and accretion mechanisms in the X-ray sources.





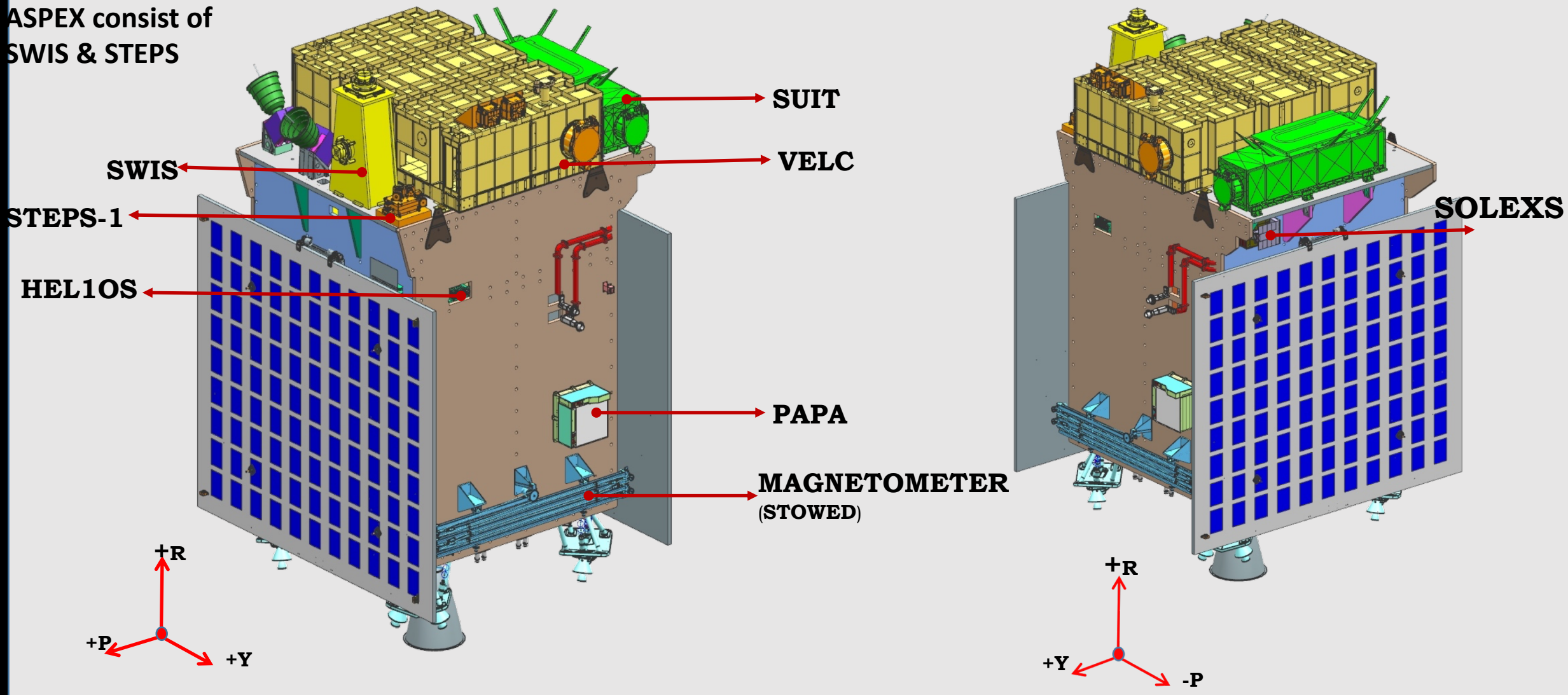
Aditya-L1 Mission

- First space-based dedicated Solar mission from India.
- Halo orbit around the Lagrangian point 1 (L1) of the Sun-Earth system (at a distance of about 1.5 million km from the Earth).
- Major advantage: continuously viewing the Sun without any occultation/eclipses.
- Would provide crucial information in understanding the impact of solar activities on near Earth space weather.



Schematic of the perspective of the Aditya-L1 mission:
Not drawn to scale

Aditya-L1 Mission: Payload Locations



Aditya-L1 Mission: Objectives

Mission Objectives:

- To design, develop, and launch an observatory class satellite and be placed at Sun-Earth Lagrangian point 1 (L1) for uninterrupted observations of the Sun
- A first Indian observatory class mission for solar & heliospheric studies
- Mission life – 5-years

Science Objectives:

- To observe the dynamical events in the solar atmosphere – Photosphere, Chromosphere and Corona
- Spectroscopic diagnostics of the coronal plasma during quiet as well as active phase
- In-situ measurements of particle and magnetic field at L1 for heliospheric studies

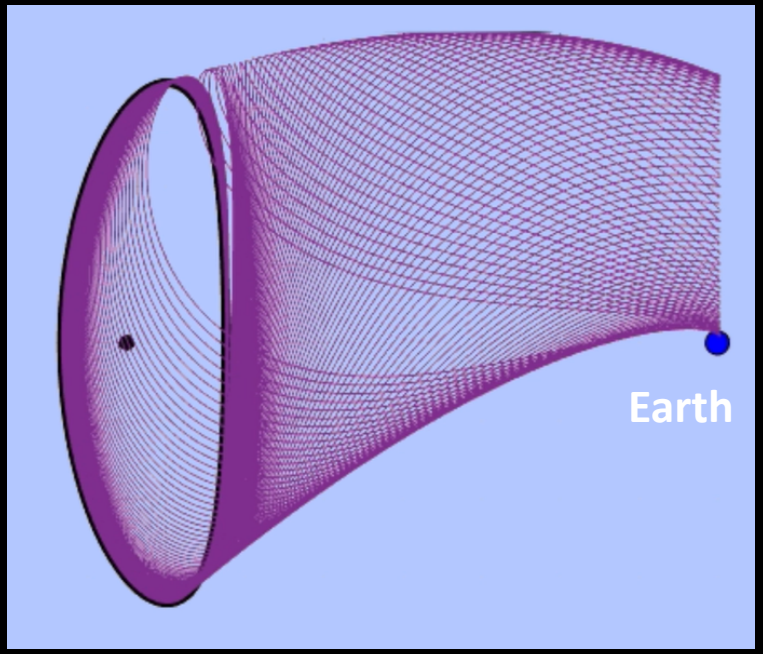
Aditya-L1 Mission: Uniqueness

- CME dynamics close to the disk ($1.05R_{sun}$) and thereby providing information in the acceleration regime which is not observed consistently.
- Coronal Magnetic Field and topology of Active regions.
- Spatially resolved solar disk observations in the near UV provide information on the radiation output from different structures.
- On-board intelligence to detect CMEs and Flares for optimized observations and data volume.
- Flare observations→ all flares to be observed without break or sensitivity change.
- Solar wind electrons, protons, and alpha particles fluxes with direction information.
- Specific identified flags and count information through telemetry for early information on the space weather events.

Aditya-L1 Mission: Challenges in Realization

First Indian Missson to L1- Challenges in Trajectory Optimization:

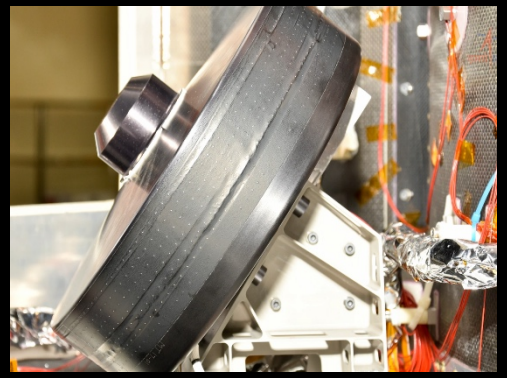
- Most optimum paths needs to be chosen considering the launch vehicle capacity, launch window constraints and fuel minimization during Earth-bound maneuvers, in the cruise phases as well as orbit maintenance.



Stringent pointing accuracy and stability:

- The science goals of Aditya-L1 demands **15 arc-second** pointing accuracy and spacecraft stability within **5 x10^{-5} deg/s**.
- This is achieved through high-accuracy pixel sensor, magnetically suspended reaction wheels and accurate star sensors developed for Aditya-L1.

High-accuracy pixel sensor



Magnetically suspended reaction wheels

Aditya-L1 Mission: Challenges in Realization

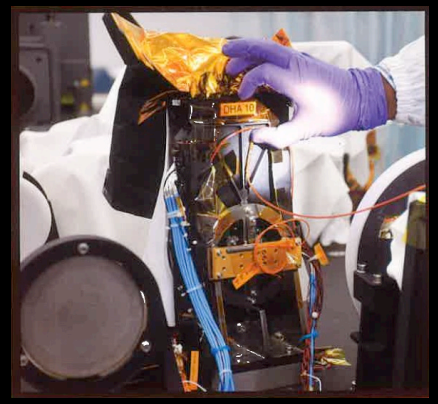
Magnetic cleaning and sub-system magnetic field requirements:
The measurement of in-situ inter planetary magnetic field is affected by spacecraft own magnetic field. Therefore the field of the spacecraft to be minimzed and also to be known accurately:

- New spacecraft harness routing developed to magnetically clean the spacecraft.
- New facility was developed to measure sub-system magnetic field of spacecrafts sub-systems.

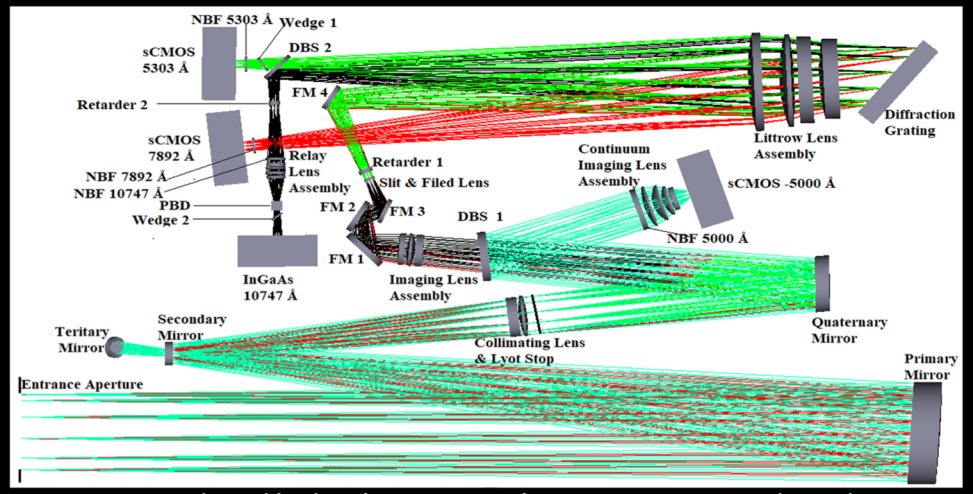
Design and developments of state of the art optical components for payloads:
About 40 state-of-the-art optical components are developed for VELC payload with stringent contamination control requirements.

Stringent contamination control requirements:
Stringent contamination control for Aditya-L1 payloads and spacecraft. For VELC & SUIT payloads it is Class 100 requirements.

Sub-system magnetic field measurement facility

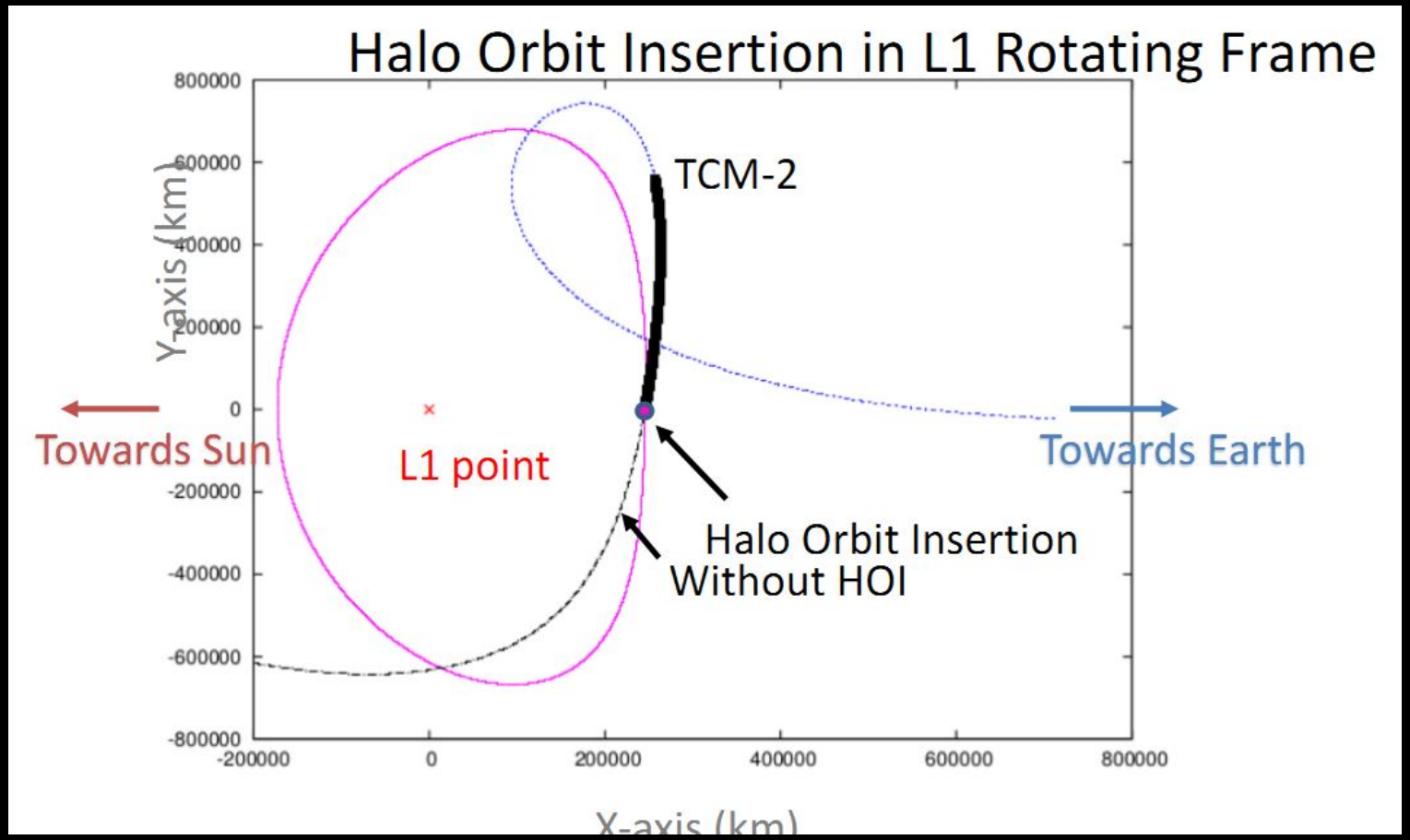

Optical components


VELC Payload



Solar light journey in VELC payload

Halo Orbit Insertion



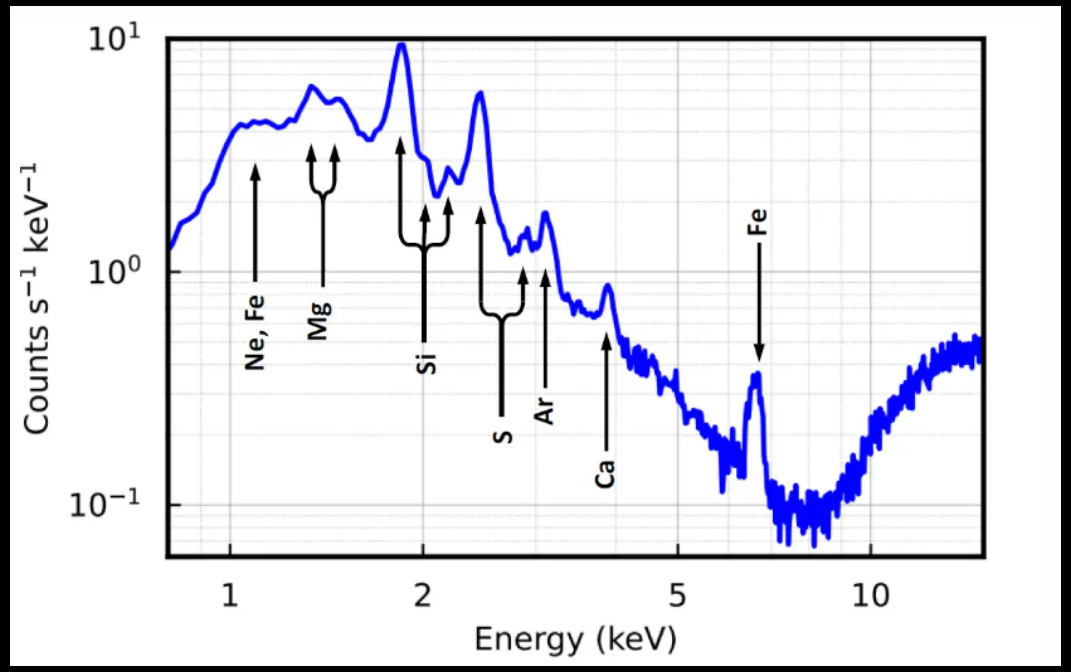
Halo Orbit Insertion in L1 Rotating Frame

Achieved on January 6, 2024

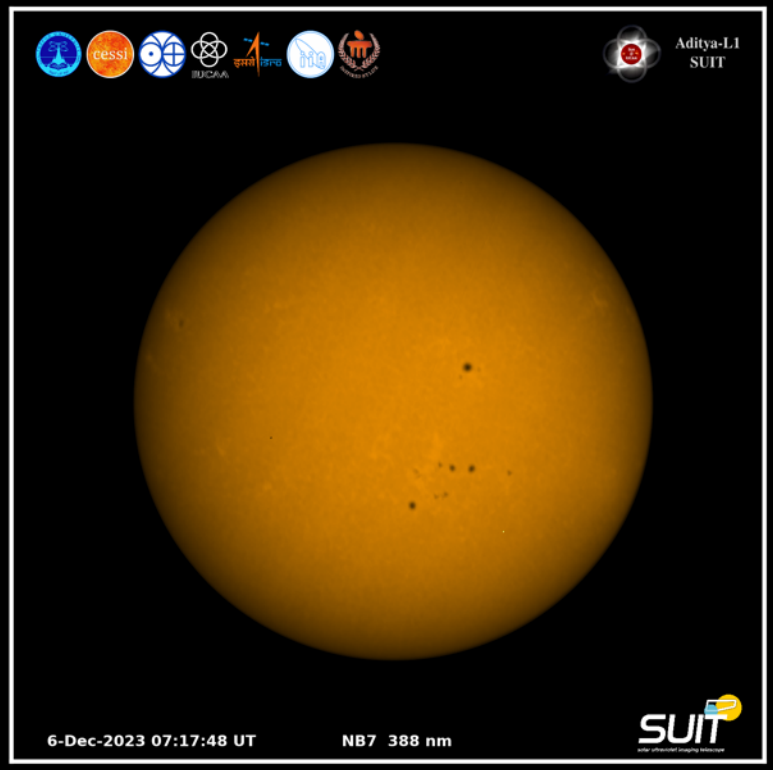
Aditya-L1 Mission: Primary Science

- Address plasma diagnostics of large and small-scale structures in the corona
- Address origin and dynamics of CME's and Flares → drivers for space weather models
- Explore Coronal magnetic topology & Active region Coronal magnetic fields
- Coronal Abundance studies & FIP variations during solar flares
- Prominence Studies → Quiescent and eruptive prominences
- Study the directional and energy anisotropy of solar wind using Multi-direction observations
- Origin of supra-thermal and energetic particles → isolate the flare related accelerated energetic particles to that of CME shock related
- Measure and monitor the spatially resolved solar spectral irradiance in the Near UV

Quick-Look Science from Aditya-L1



XSPECT sees supernova remnant Cassiopeia A (Cas A).



Full disc image of the Sun in UV (388 nm wavelength)

Summary

- India launched X-Ray Polarimetry mission XPoSat and Solar Observatory Aditya-L1
- The missions are successful
- All the scientific payloads are normal
- Payload Verification (PV) phase started for both the missions
- Science data, according to the data policy, will be available through Indian Space Science Data Centre Portal

Thank you for kind attention