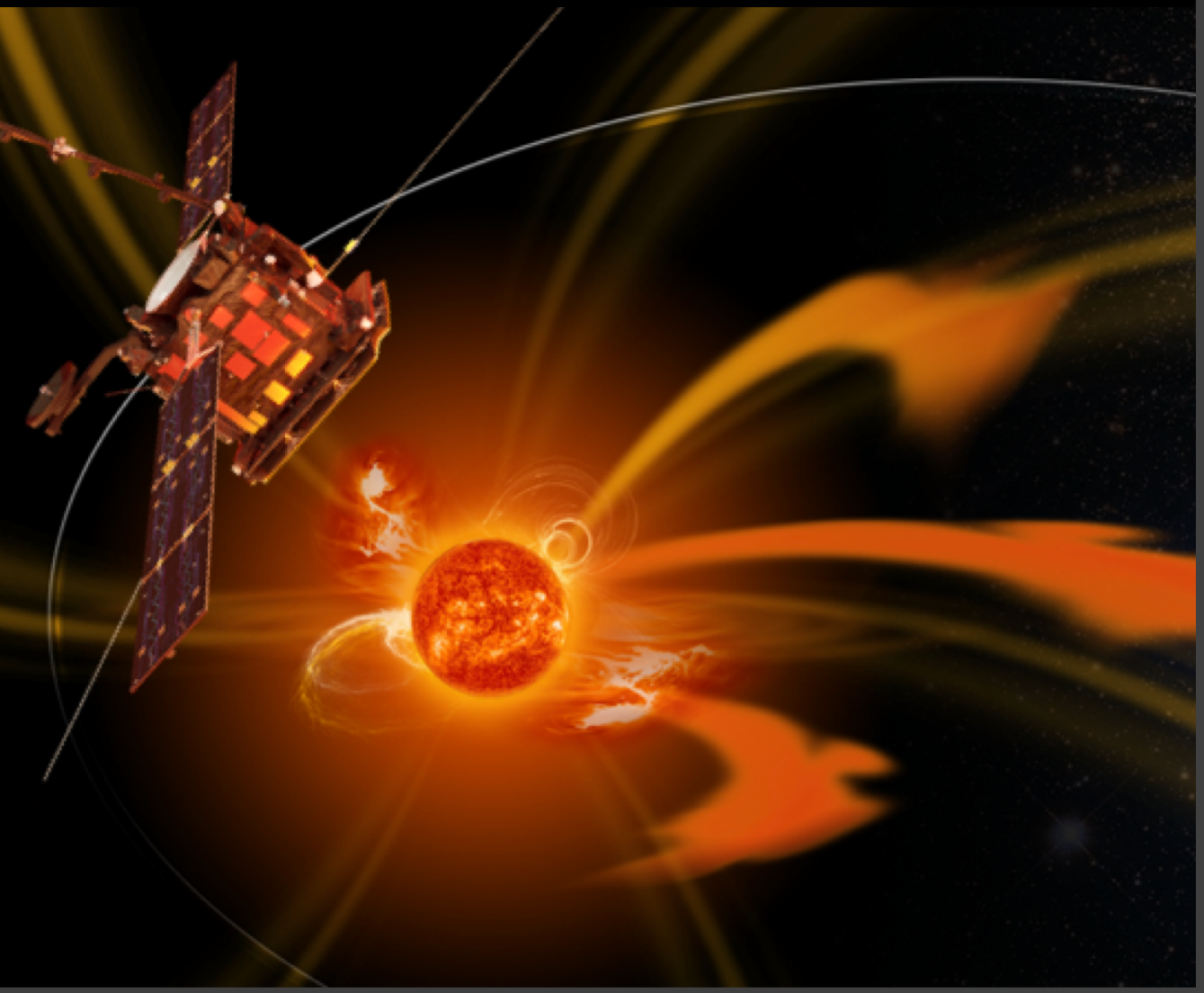
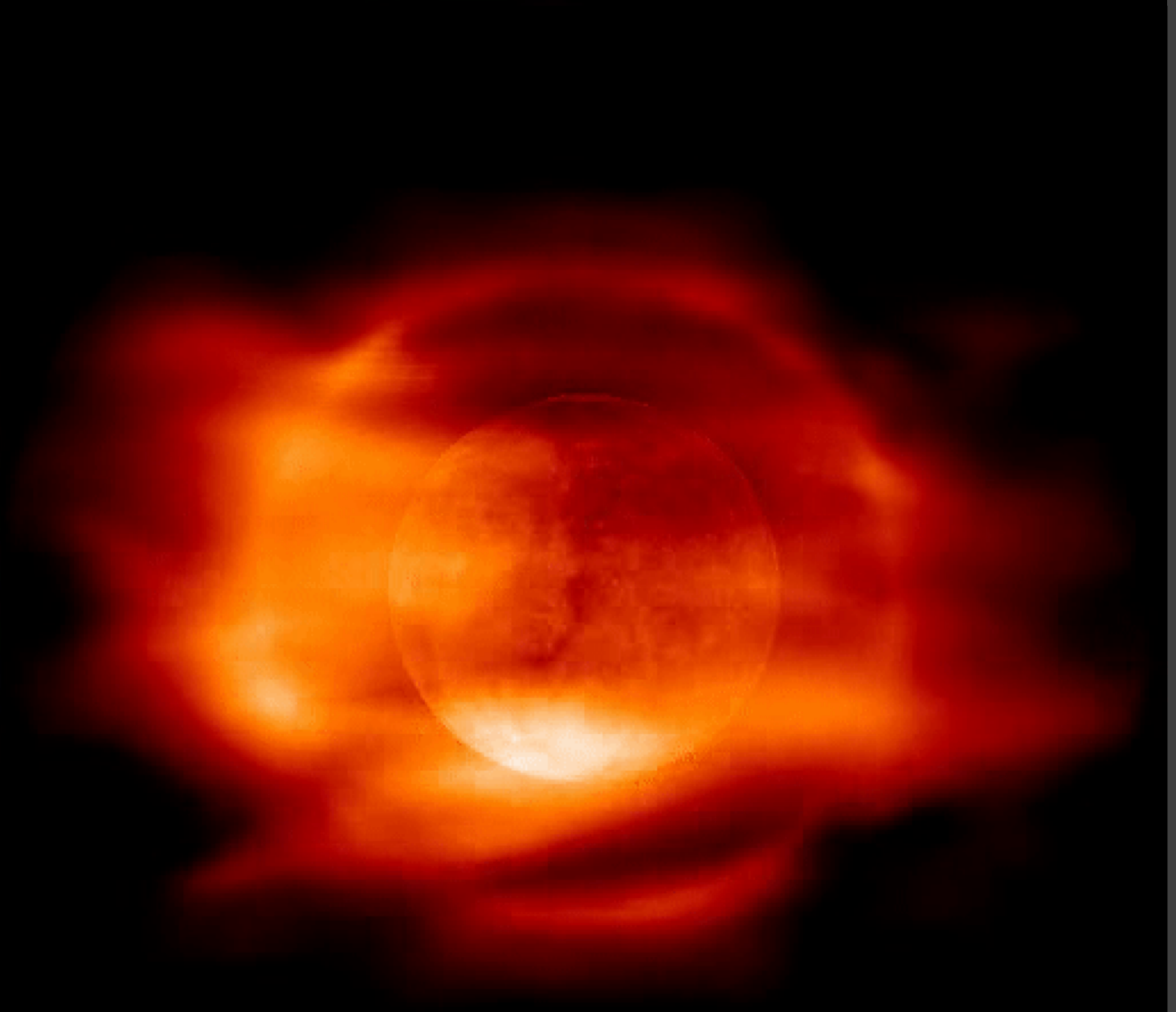


A journey to the polar regions of a star:

Exploring the solar poles and the heliosphere from high helio-latitude

Louise Harra (team leader), PMOD/WRC & ETH Zürich

Silvano Fineschi (presenting) INAF – Astrophysical Obs. of Torino



Tomographic reconstruction of coronal OVI line emission from data of the UVCS and EIT onboard SOHO

A journey to the polar regions of a star: Exploring the solar poles and the heliosphere from high helio-latitude

Earth's poles - explored

Jupiter's poles – explored

Saturn's poles - explored

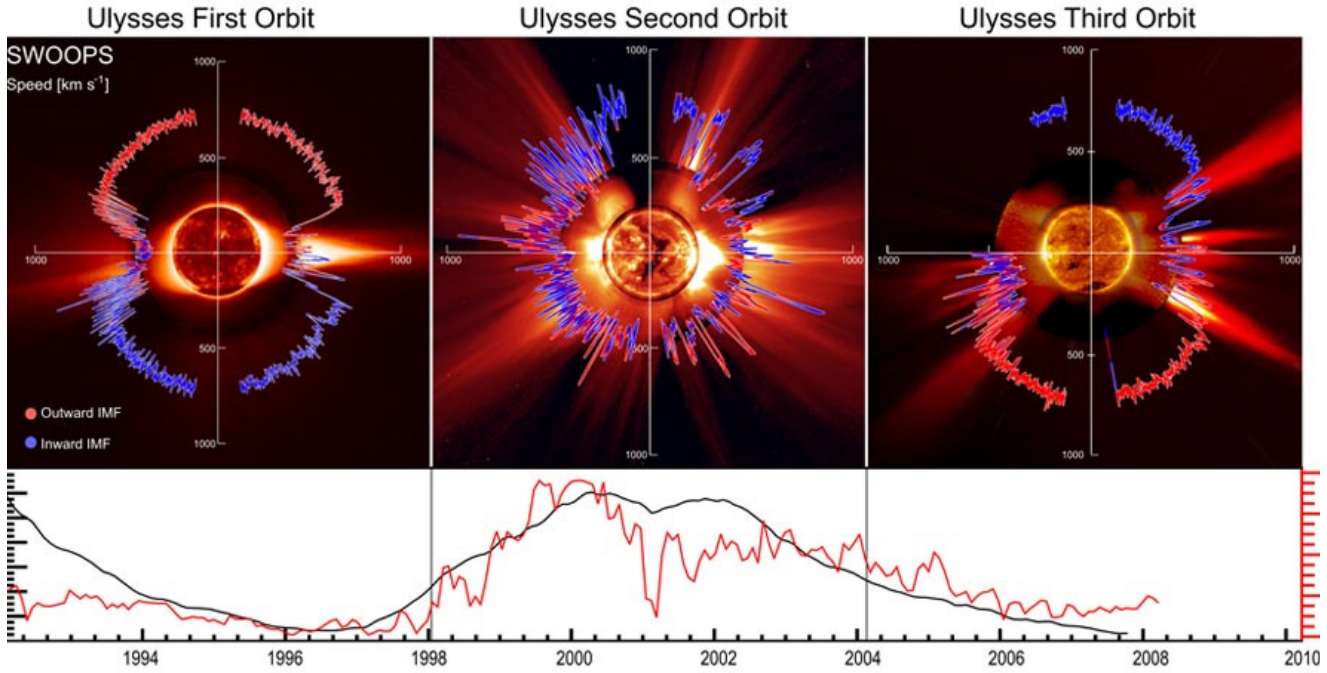
Mars's poles - explored

Sun's poles – still a mystery!

What do we know about the solar poles?

The poles dominate the global magnetic field, and behavior of the cycle, and is a location of fast solar wind.

Ulysses made big strives in understanding the location and behavior of the fast and slow solar winds, but had no remote sensing instruments.

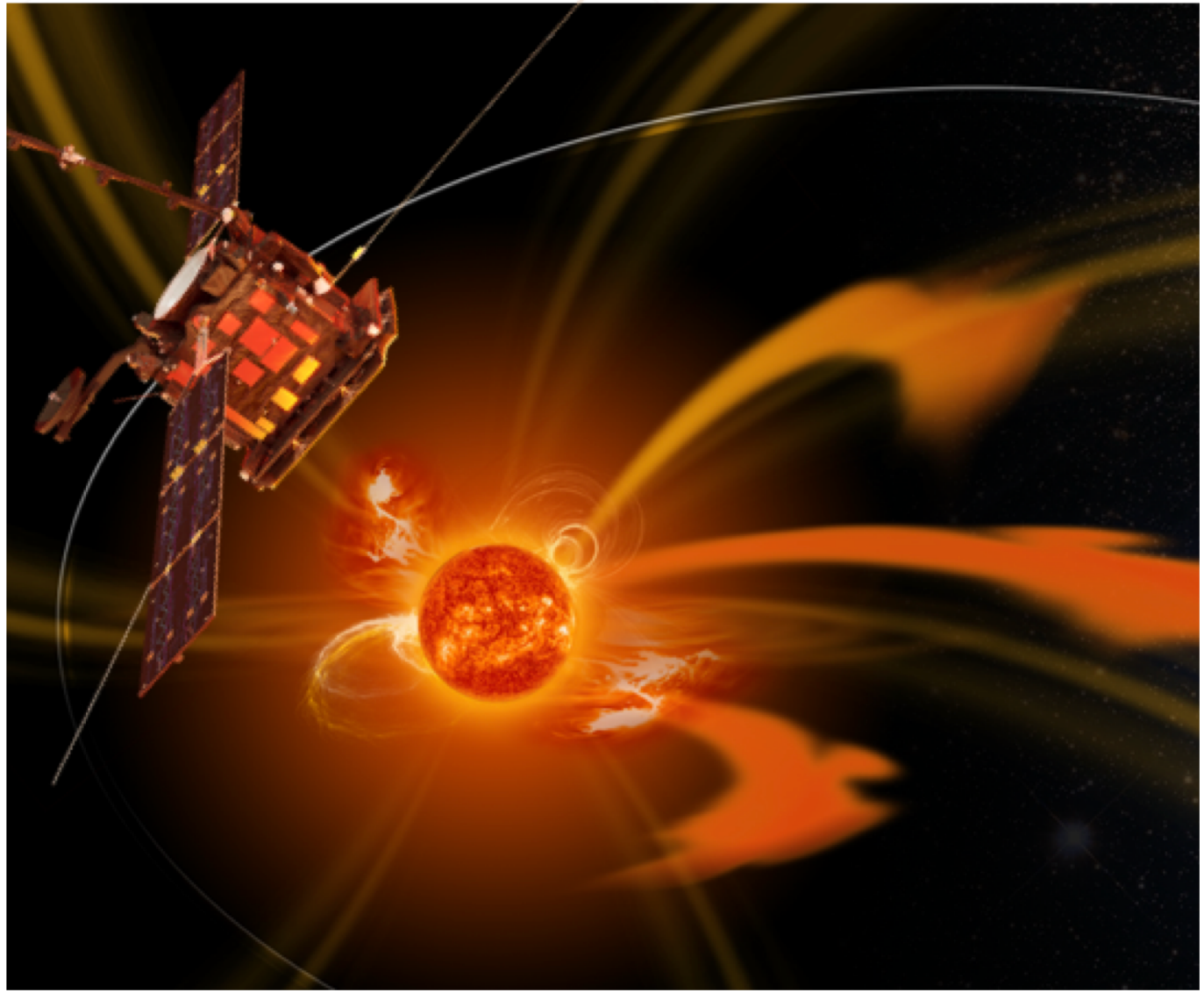


What will we know about the solar poles in the next decade?

We will have the first ever view of the poles with remote sensing and in-situ instruments.

Solar Orbiter is launched next year probing the creation and fluctuations in the heliosphere.

After the nominal mission it will reach 32 degrees out of ecliptic.



What will we be missing, and why do we need a polar mission?

Our science goals

To study the interior of the solar polar regions to uncover the key role of magnetic flux transport in the solar cycle

To study the global mass-loss of a star through discrete mass ejection processes

To determine solar irradiance at all latitudes

To explore solar activity at the poles and the impact on the solar wind

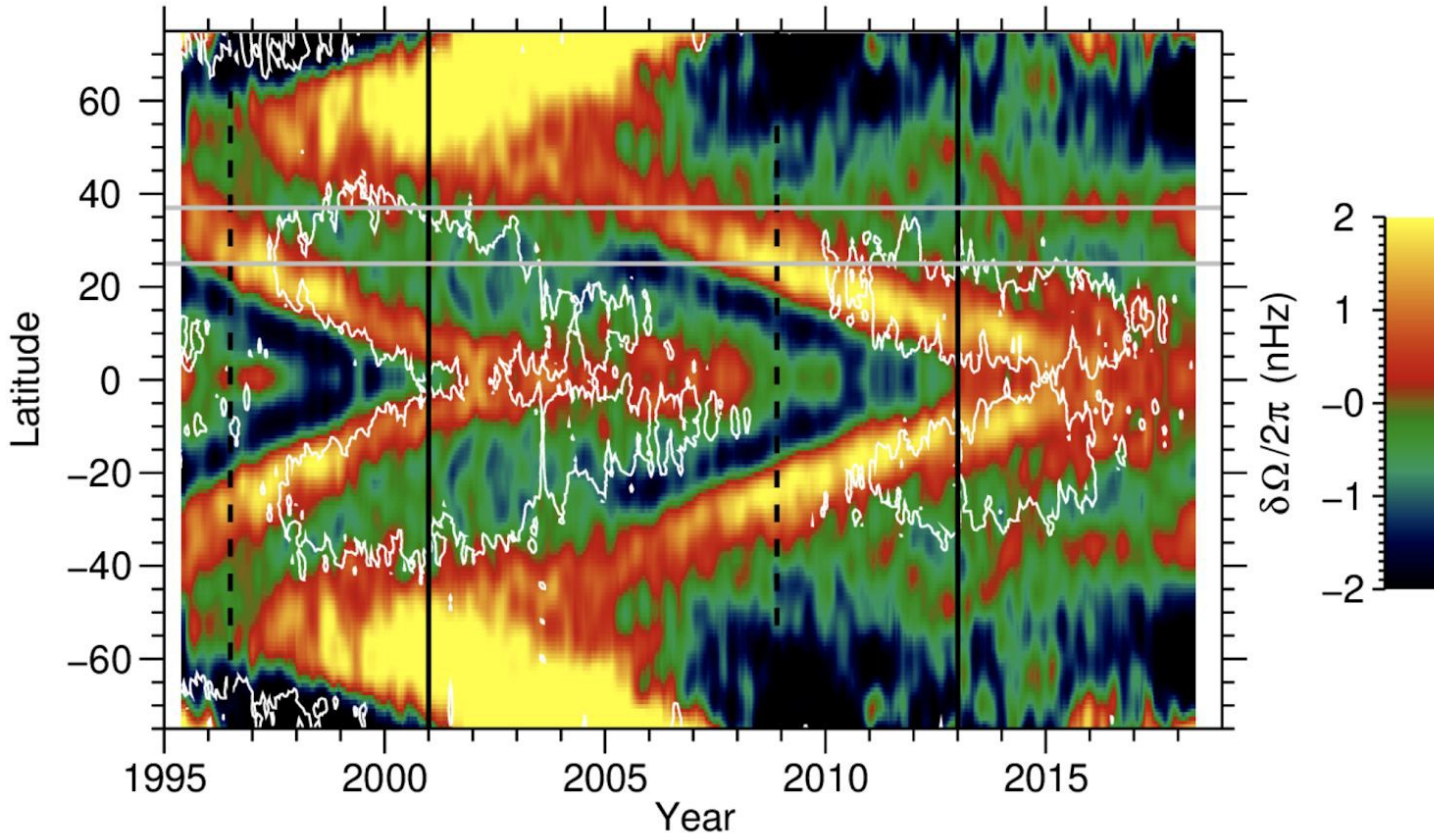
Requirements of the mission *What makes this concept unique?*

The mission should reach latitudes > 60 degrees out of ecliptic.

The mission should reach < 1AU to the Sun

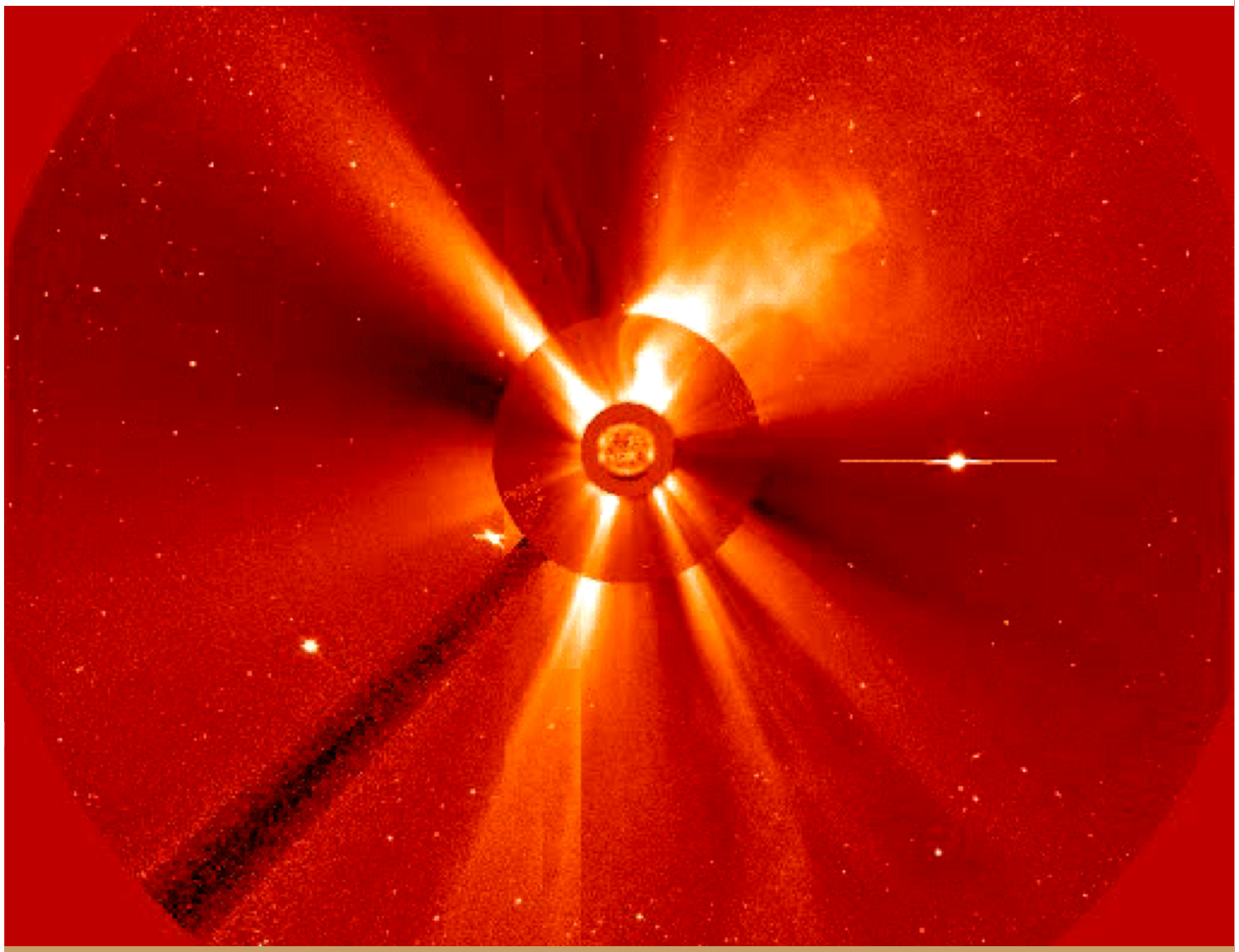
The mission should observe for >tens of days at the poles for each orbit.

The mission should be long duration, covering at least half a solar cycle.



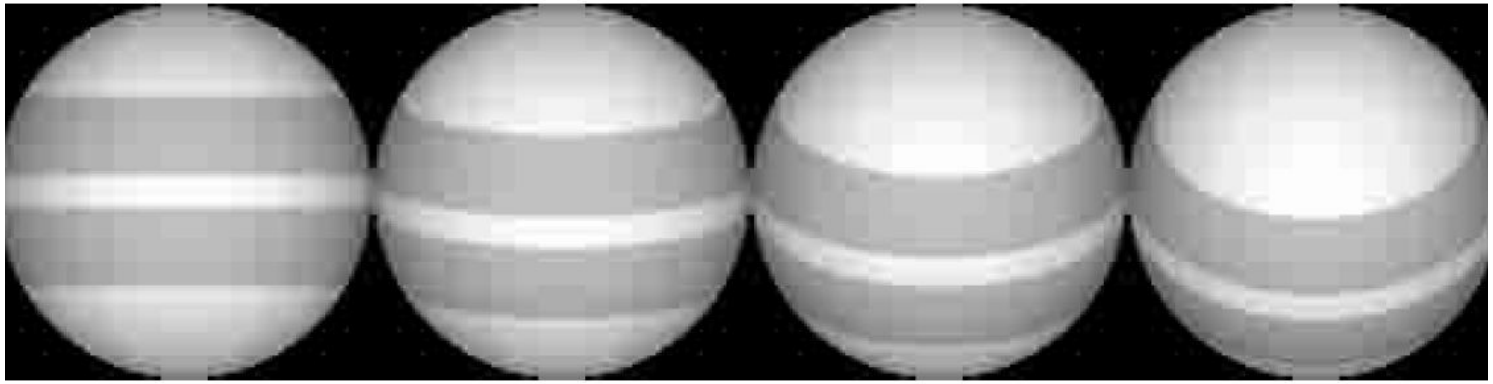
SG1: To study the interior of the solar polar regions to uncover the key role of magnetic flux transport in the solar cycle

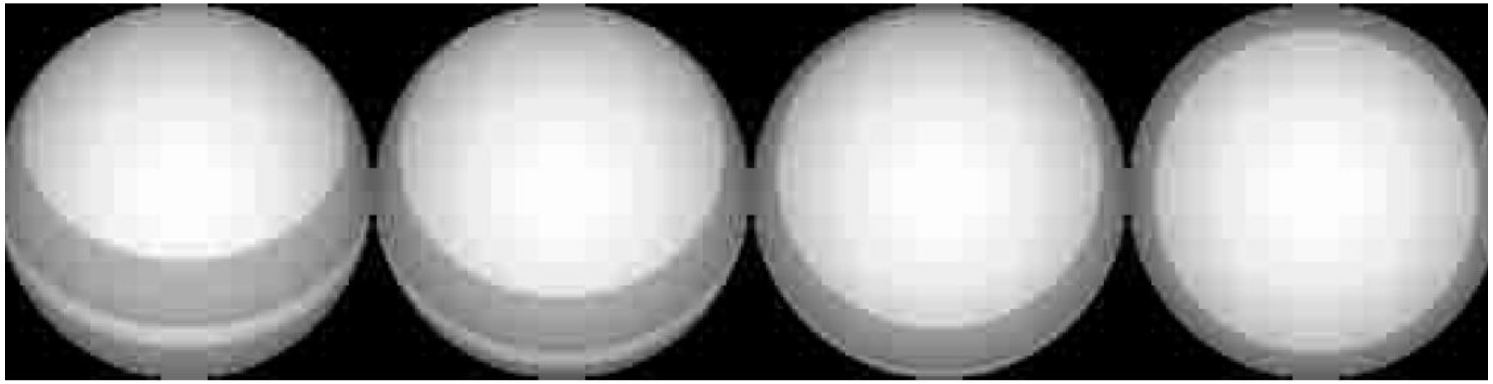
- Helioseismology techniques in the past decades have revealed much of the structure inside the Sun.
- But the accuracy decreases as the poles are approached.
- We need long observations of the poles, to reveal internal flows that create and drive the solar cycle.



SG2: To study the global mass-loss of a star through discrete mass ejection processes

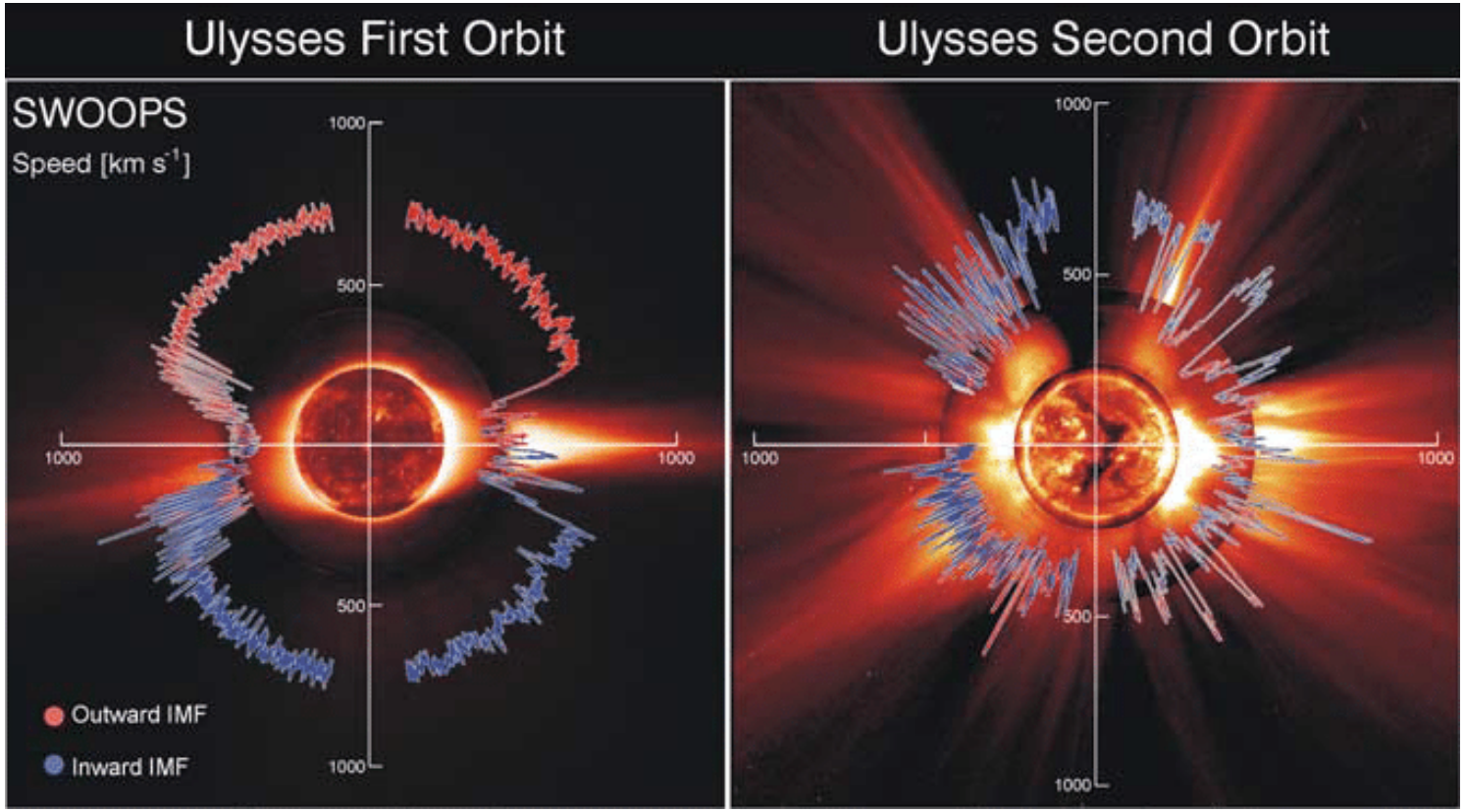
- High latitude vantage point allows the study of global mass-loss
- Detecting ALL coronal mass ejections at once!
- Tracking co-rotating interaction regions globally.
- Strong links to stellar mass loss, and habitability of exoplanets.





SG3: To determine the solar irradiance at all latitudes

- Measurements above the equator will provide the first order estimate of the solar luminosity for the first time.
- Measure the latitudinal distribution of the solar irradiance and how it varies with time for the first time.
- Strong links with understanding stellar physics.



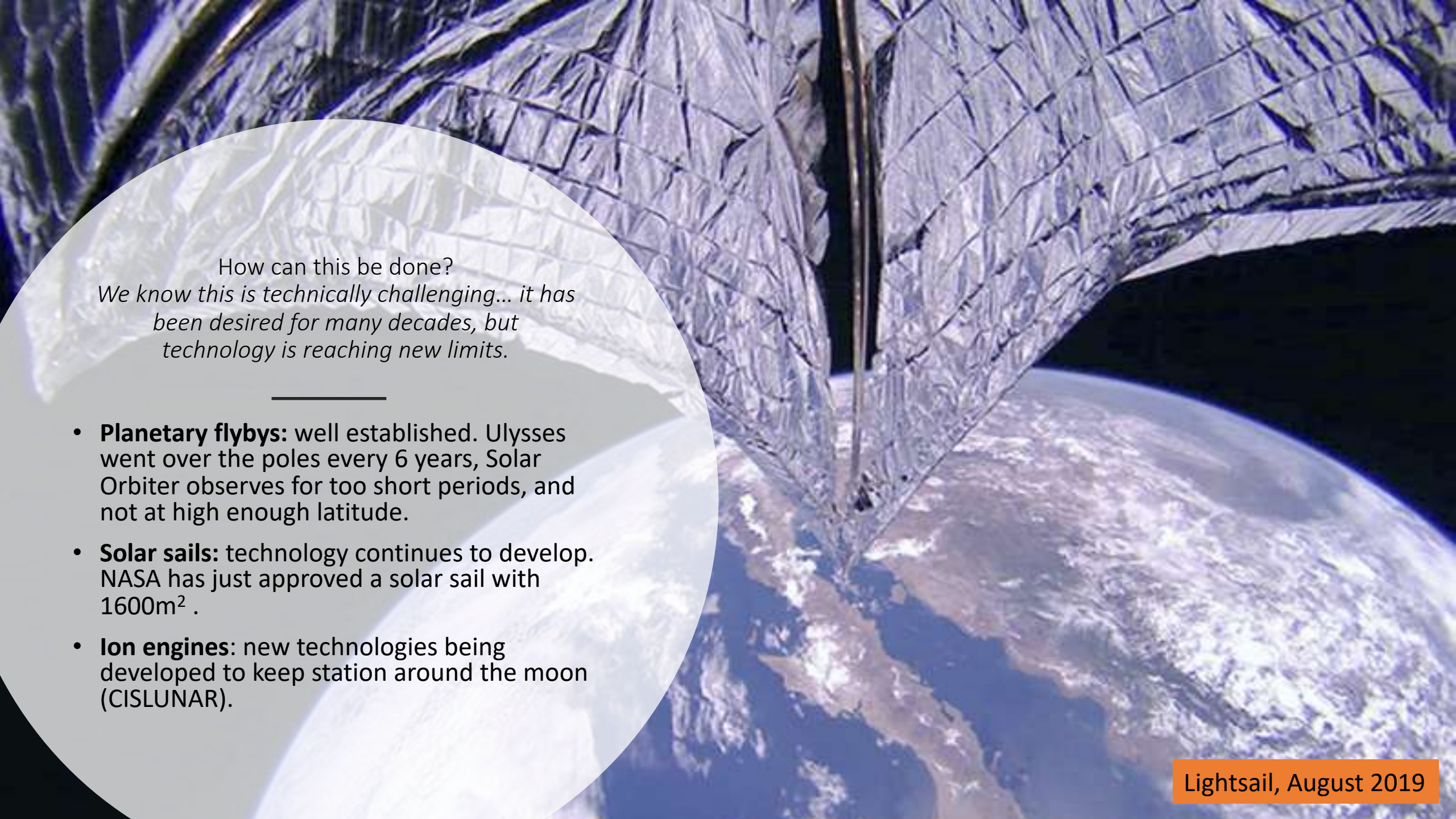
SG4: To explore solar activity at the poles and its impact on the solar wind

- Identifying fast solar wind sources and acceleration.
- Global knowledge of the solar wind, its sources and in-transit dynamics.
- Magnetic field measurements at the poles will constrain global models used for space weather prediction.

How can this be done?

We know this is technically challenging… it has been desired for many decades, but technology is reaching new limits.

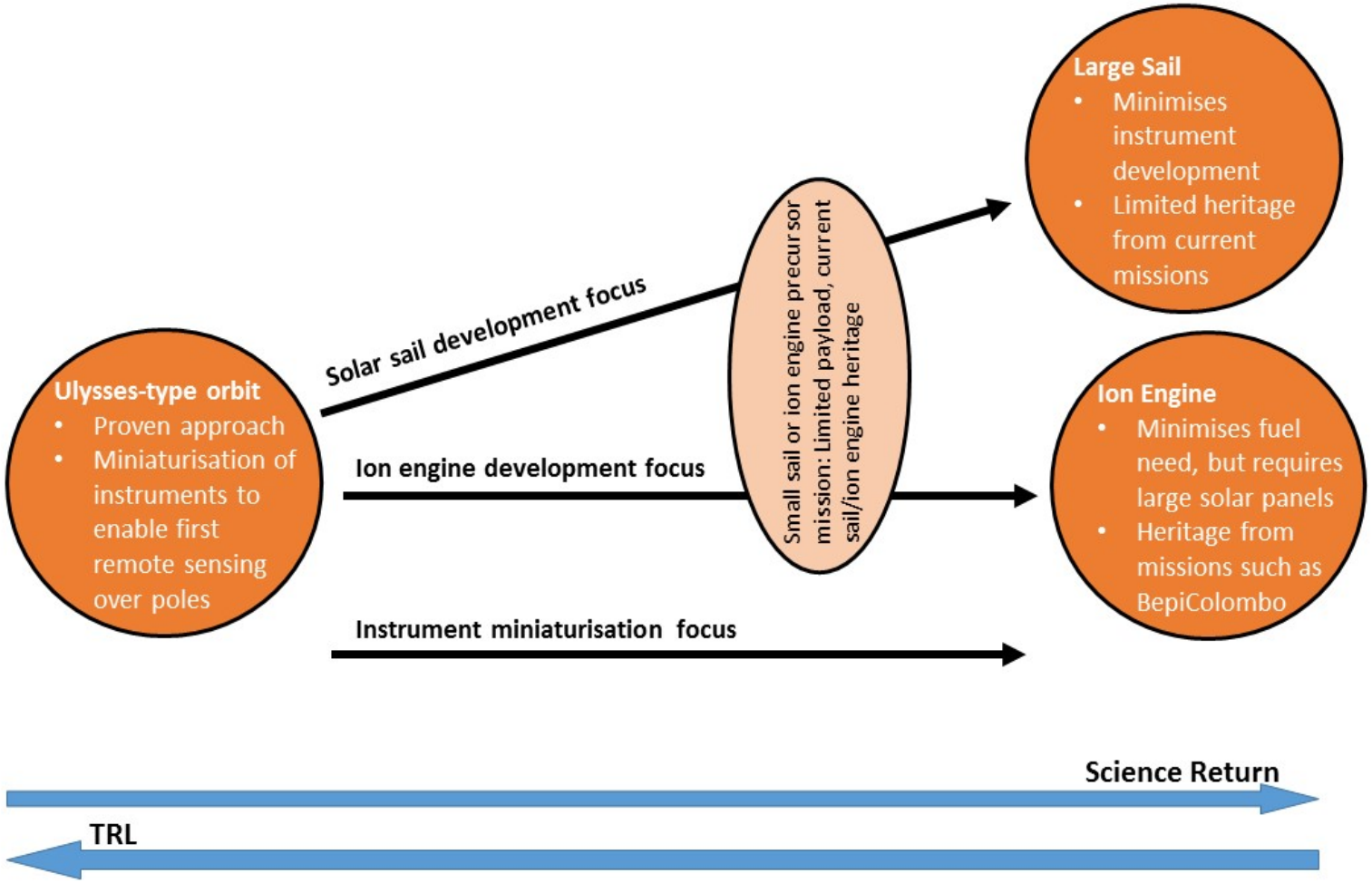
- **Planetary flybys:** well established. Ulysses went over the poles every 6 years, Solar Orbiter observes for too short periods, and not at high enough latitude.
- **Solar sails:** technology continues to develop. NASA has just approved a solar sail with 1600m^2 .
- **Ion engines**: new technologies being developed to keep station around the moon (CISLUNAR).



Lightsail, August 2019

How to progress?

- Solar sail and ion engines are developing technologies.
- A small technology satellite could be trialed as a pre-cursor, with a single instrument payload.
- The full mission could then follow on from this.



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Ulysses-type orbit

- Proven approach
- Miniaturisation of instruments to enable first remote sensing over poles

Large Sail

- Minimises instrument development
- Limited heritage from current missions

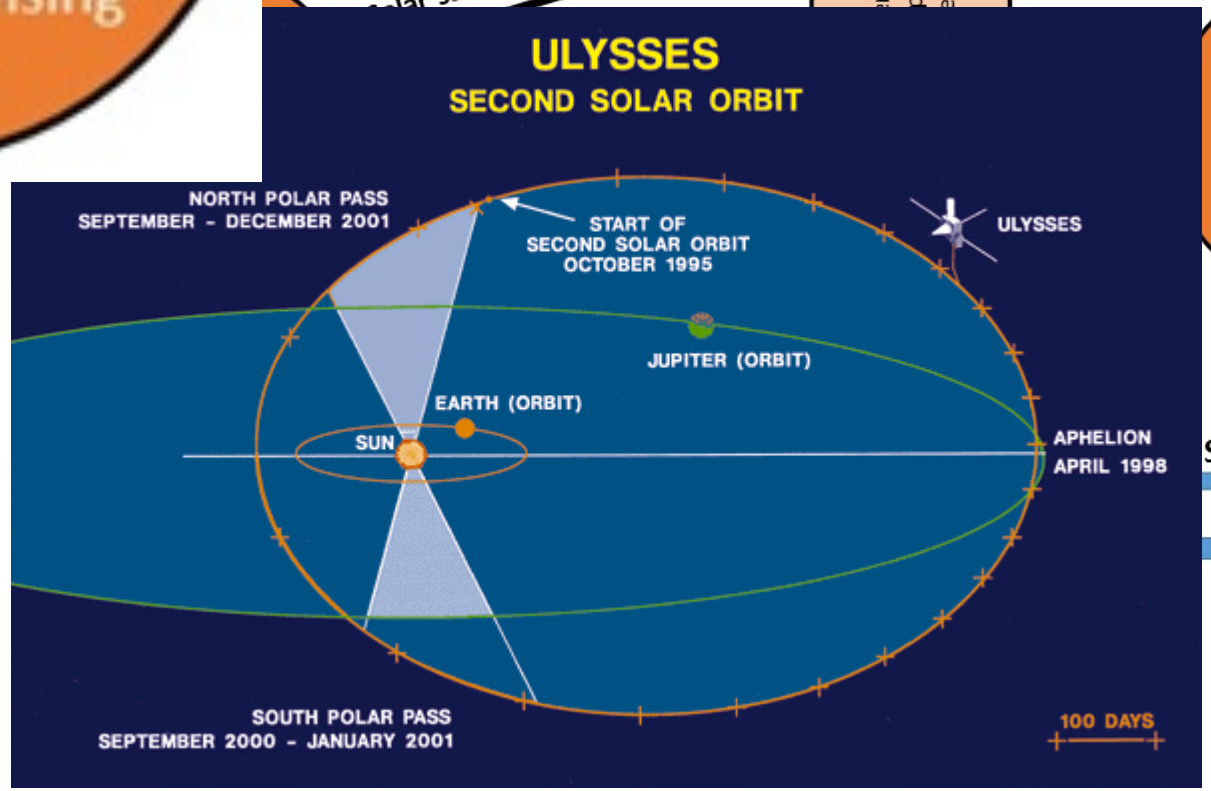
olar sail development focus

engine precursor
payload, current
eritage

Ion Engine

- Minimises fuel need, but requires large solar panels
- Heritage from missions such as BepiColombo

Science Return



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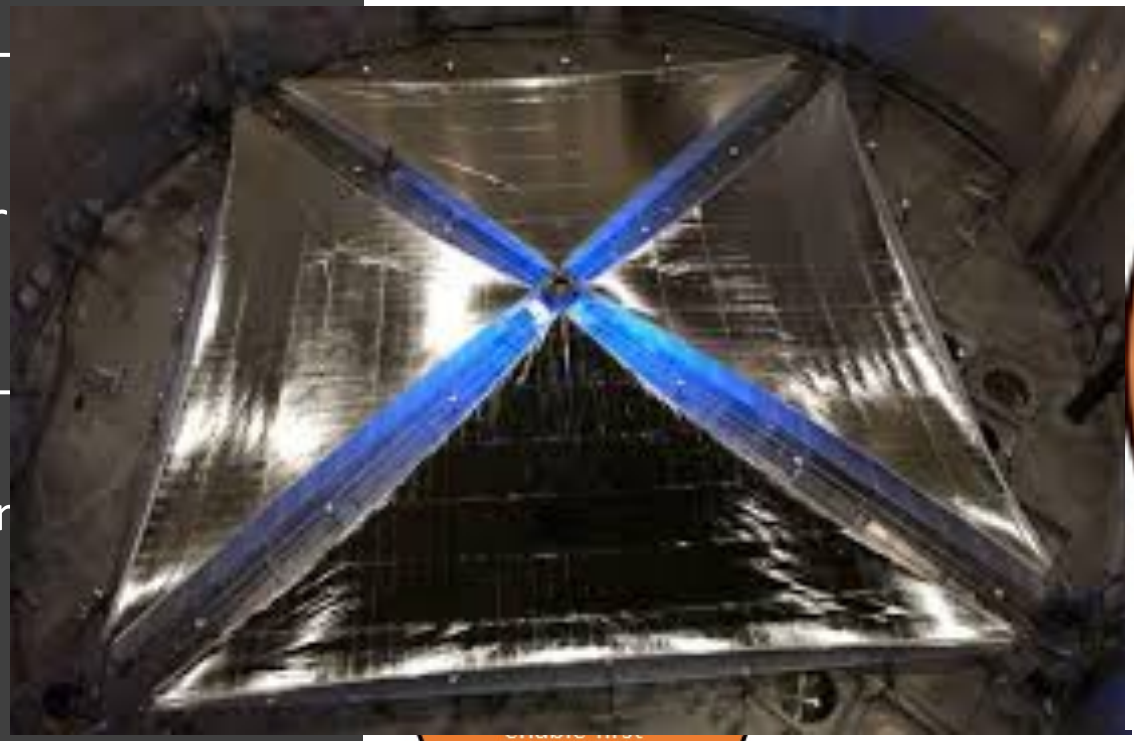

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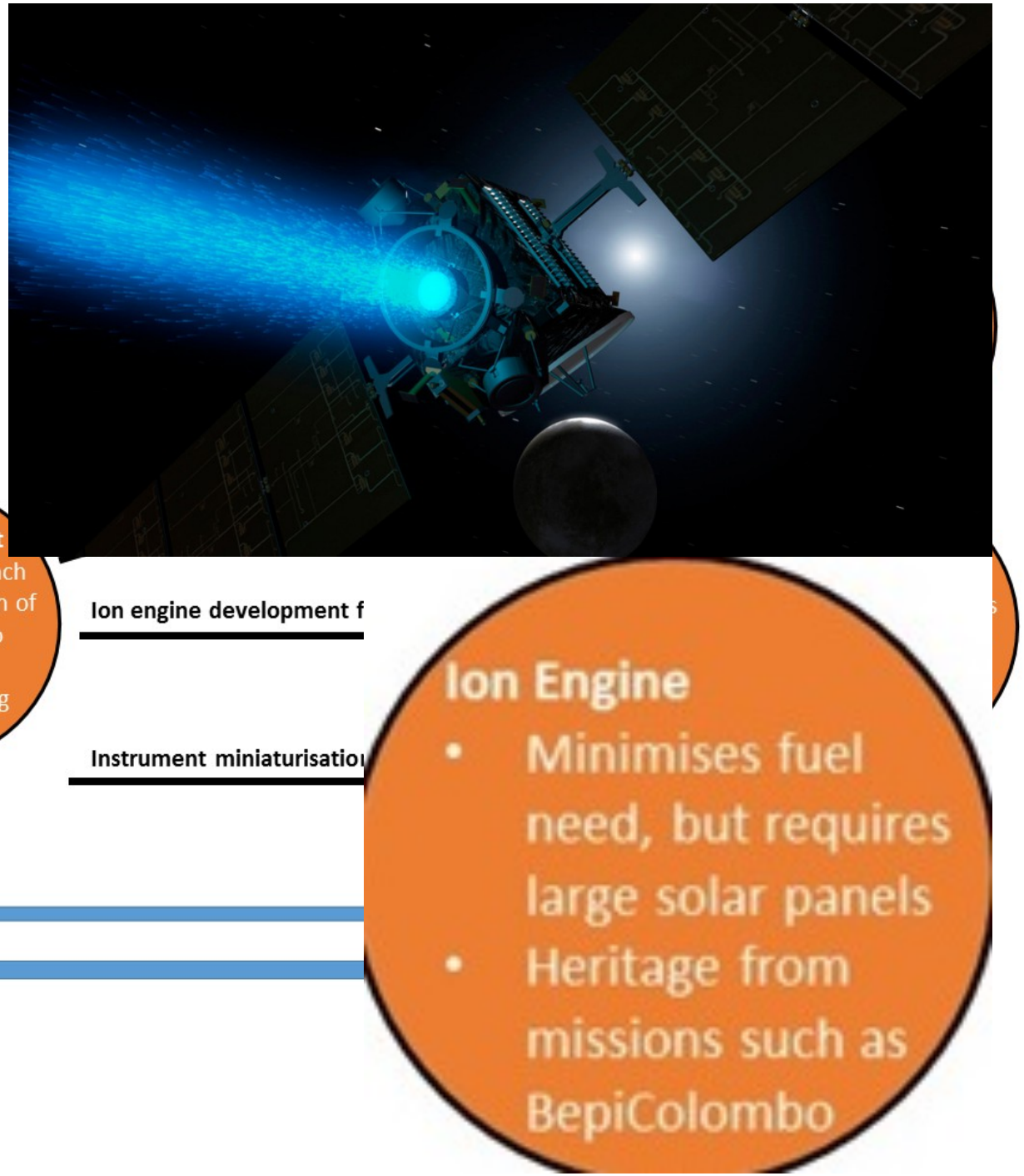

A polar mission has been dreamt of for decades.

The technology is getting close to be able to achieve this exploration of the Sun’s poles.

Impacts on our fundamental understanding on how stars work, how the Sun’s activity works.

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