SOHO 30 years:

New and Future missions building on SOHO's legacy

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Solar Physicist inspired by SOHO

SOHO 30 years celebration, Orsay, 10/12/2025

SOHO's legacy

Over the past 30 years, SOHO made a profound and lasting impact on the field of solar and space physics:

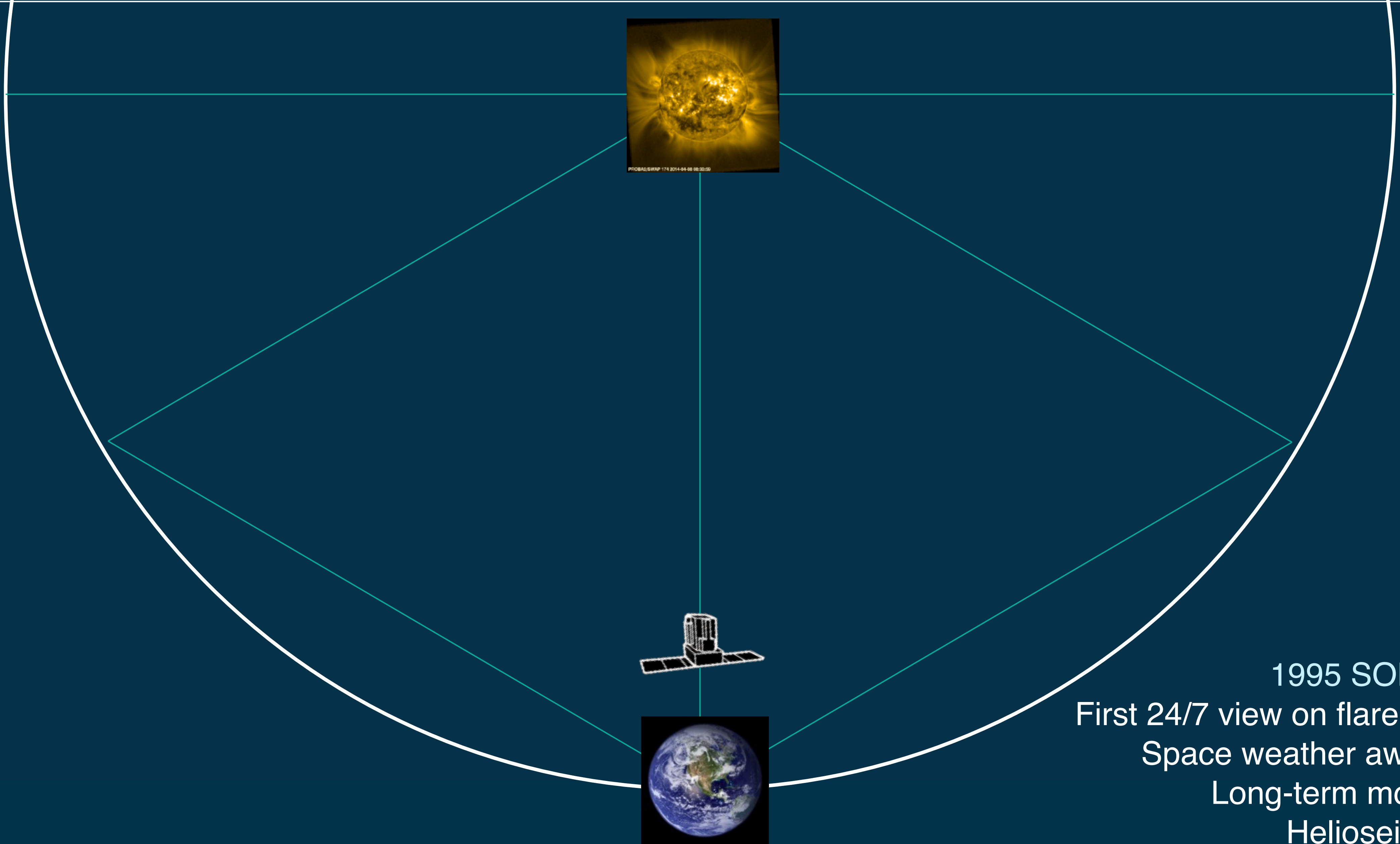
- groundbreaking **discoveries**, shaping the direction of heliophysics research
- inspiring a whole generation of **solar physicists** (~300 PhD theses)
- influencing the design, instrumentation, and scientific objectives of subsequent **space missions**

SOHO taught us the importance of:

- coordinated multi-instrument observations
- long-term solar monitoring
- continuous, stable observations for space weather monitoring and forecasting

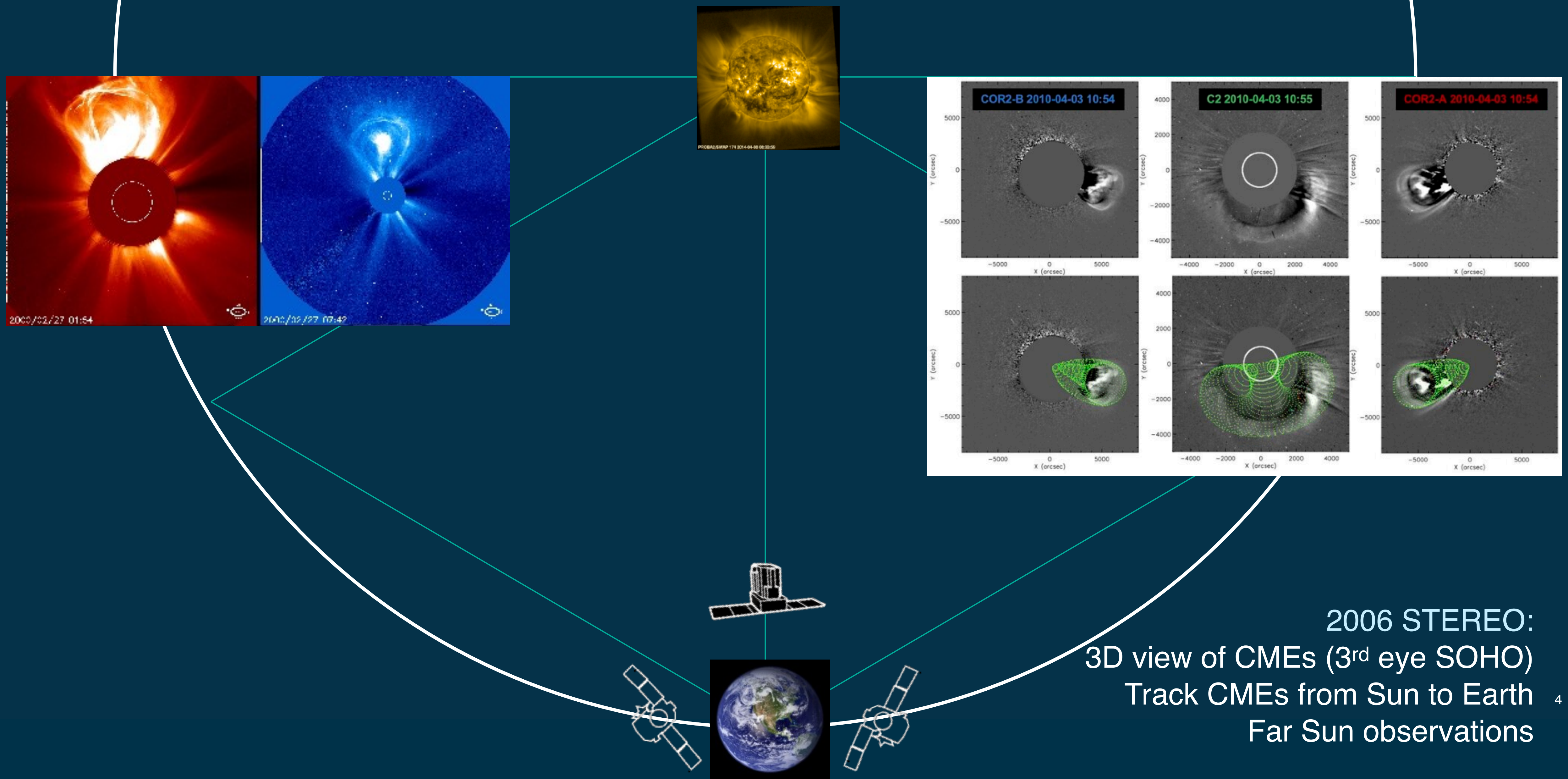
And it also showed the holes in our understanding and how to potentially address them!

New ways of looking at the Sun



1995 SOHO (L1):
First 24/7 view on flares, CMEs
Space weather awareness
Long-term monitor for
Helioseismology

New ways of looking at the Sun – stereoscopic view



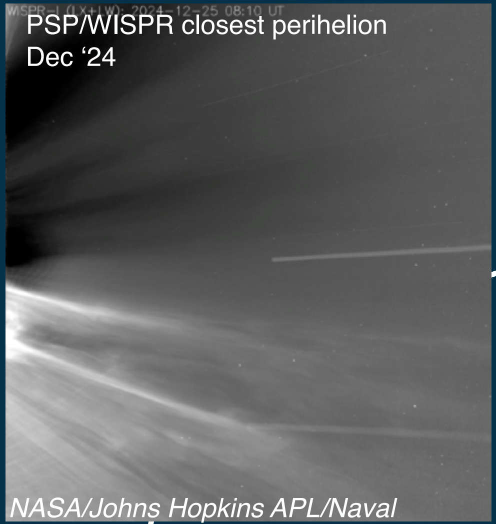
2006 STEREO:

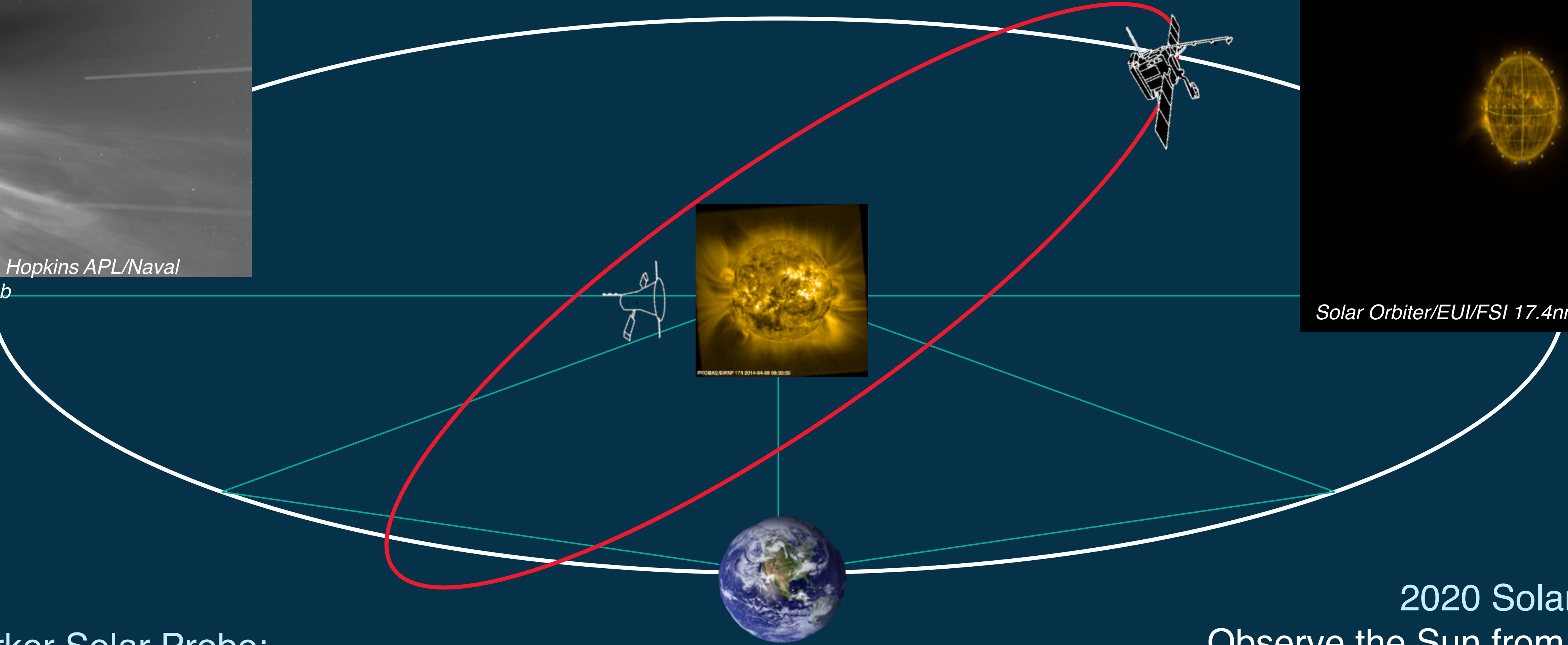
3D view of CMEs (3rd eye SOHO)

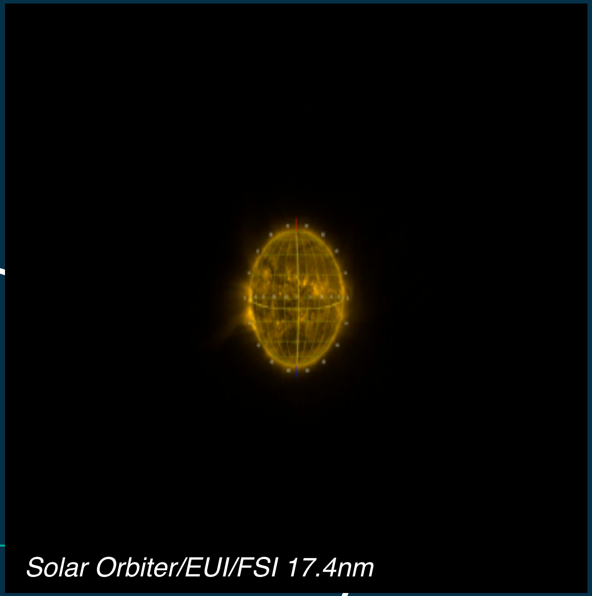
Track CMEs from Sun to Earth

Far Sun observations

New ways of looking at the Sun – Close in & polar view







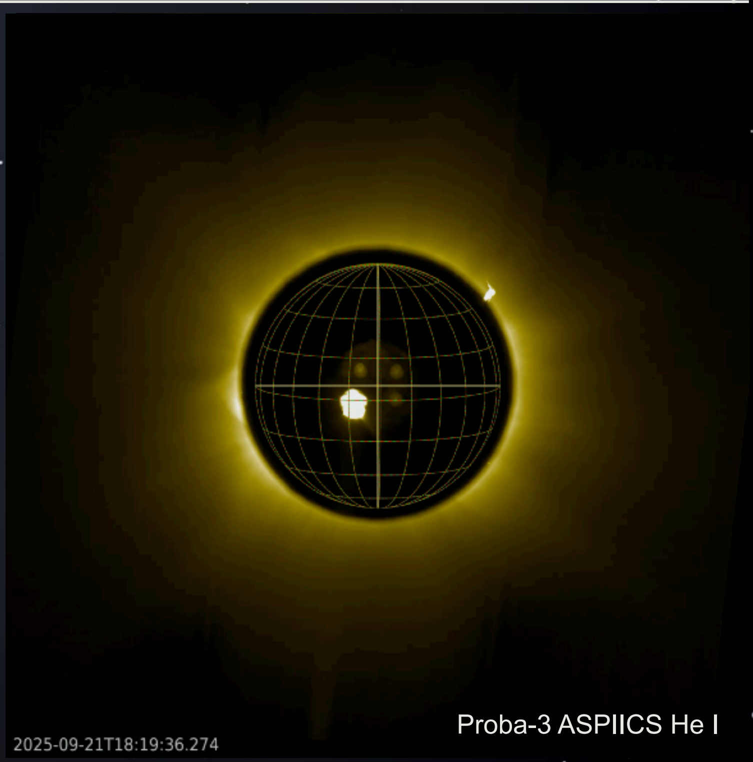
2018 Parker Solar Probe:
Dive close to the Sun to study how corona becomes solar wind (in situ)

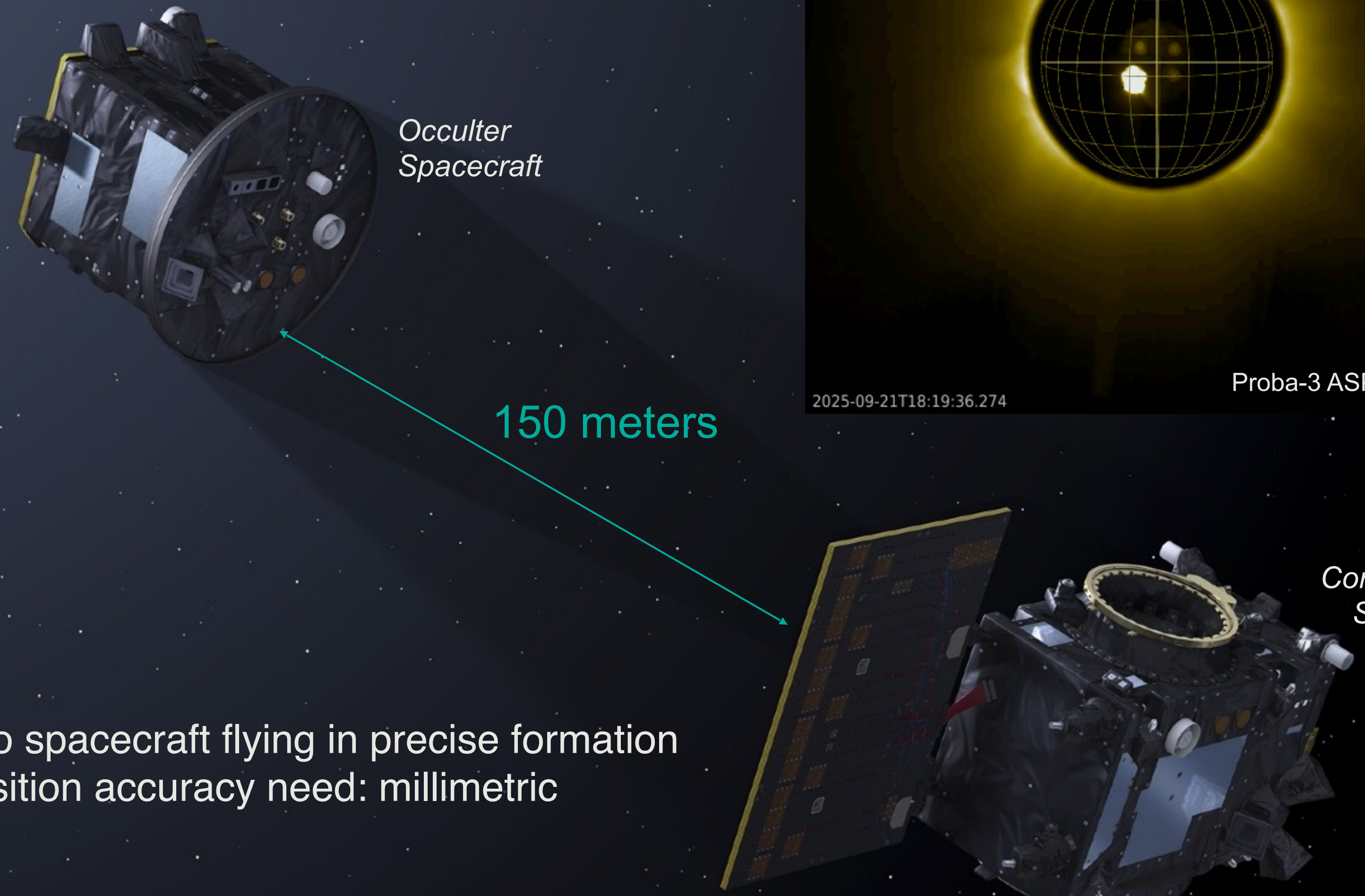
2020 Solar Orbiter:
Observe the Sun from close by
Move out of the ecliptic: poles & latitude scans
Combine Remote-Sensing with In-Situ

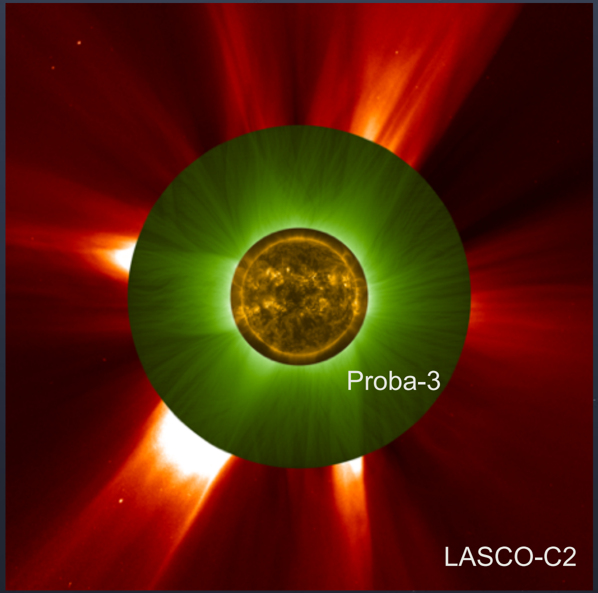
Far Sun observations – multi-spacecraft observations

Newborn missions with innovative designs: Proba-3

Dec 2024 Proba-3:
World's first precision formation flying mission
Coronagraphy closer to the solar disk than ever



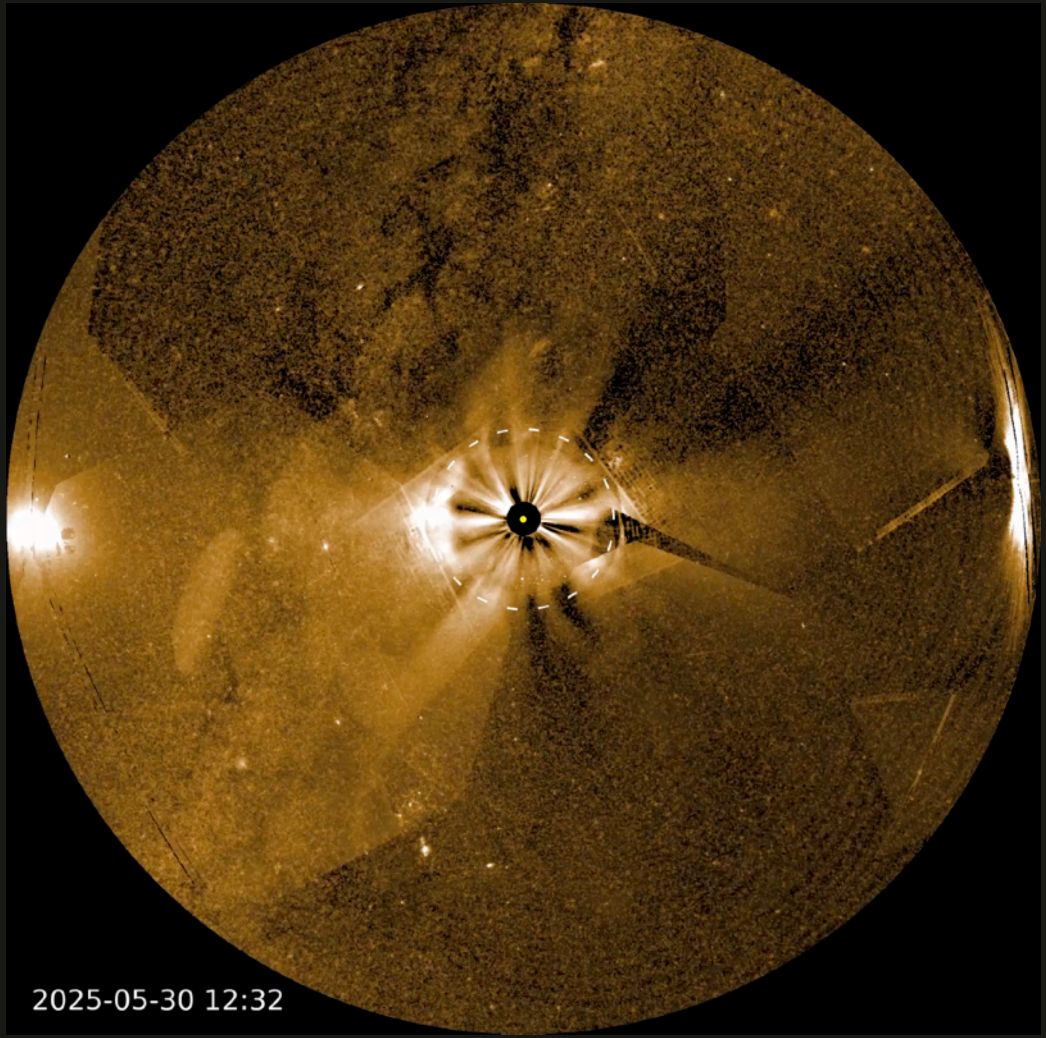


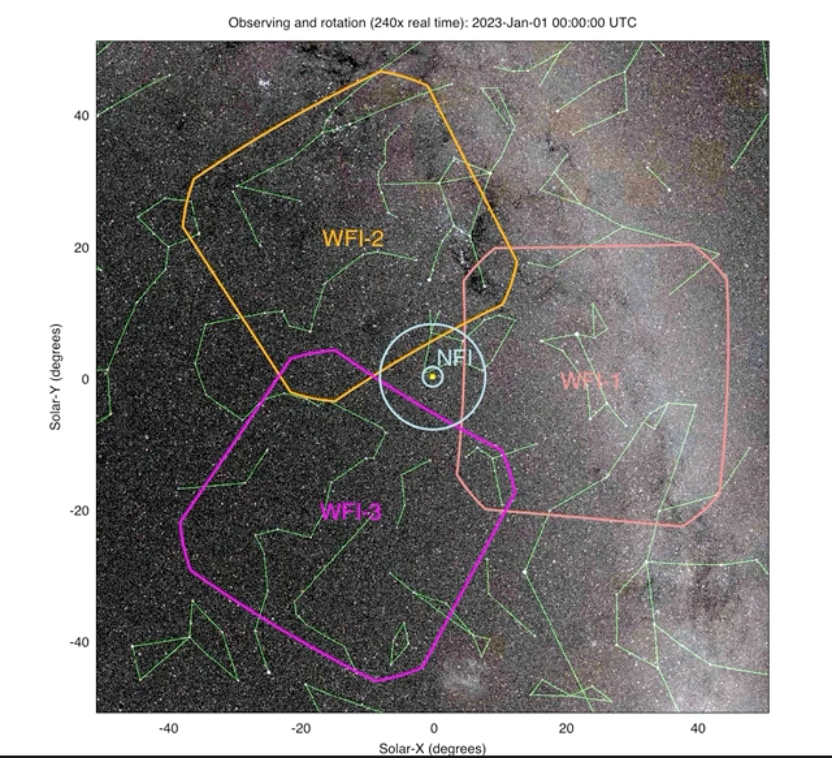


Two spacecraft flying in precise formation
Position accuracy need: millimetric

Newborn missions with innovative designs: PUNCH

PI: Craig DeForest (SwRI, Boulder)





March 2025 PUNCH:

Unique View of the Solar System

Track solar transients in all directions

Constellation of 4 spacecraft in polar LEO

Future Solar Missions – MUSE

LMSAL

Payload: MUlti-slit Solar Explorer **MUSE**

PI: Bart DePontieu (LMSAL)

Main science questions:

1. Investigate the causes of coronal heating and instability (flares and CMEs)
2. Gain insight into the basic plasma properties of the corona

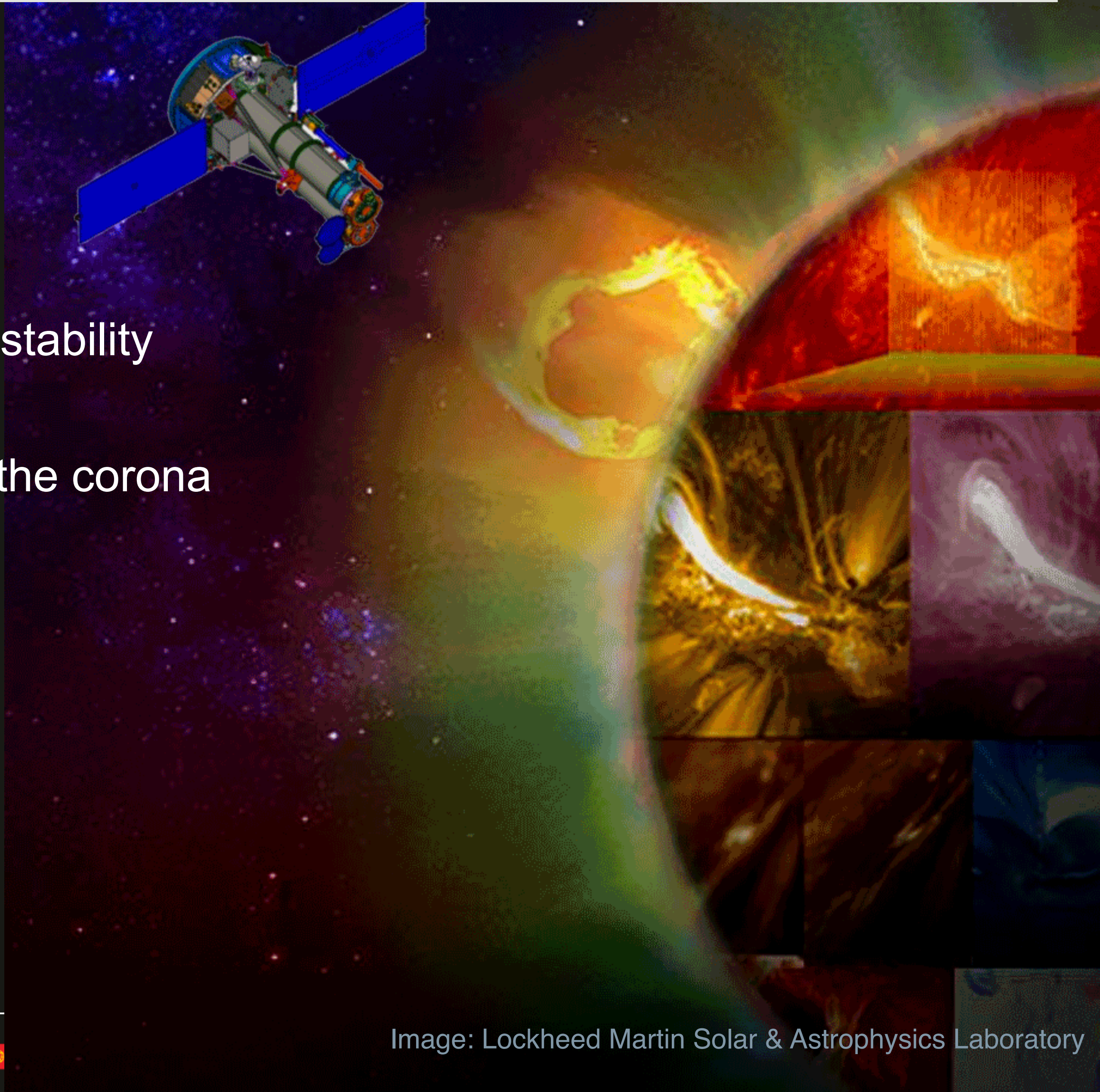


Image: Lockheed Martin Solar & Astrophysics Laboratory

Future Solar Missions – MUSE

NASA LMSAL

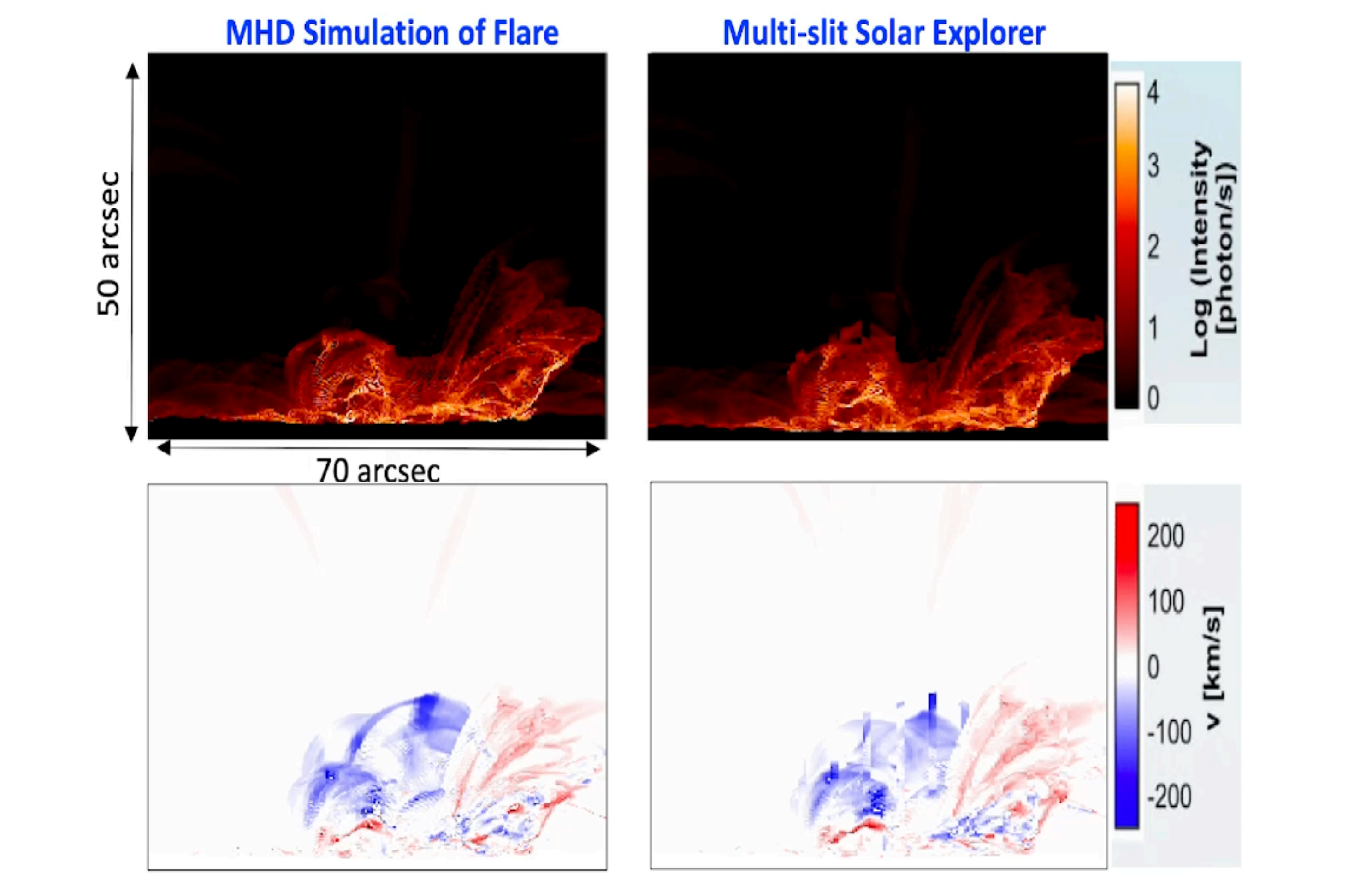
How?

EUV spectral imaging of corona

new imaging spectroscopy techniques

observe radial motion and heating at

10x current resolution and 35x faster



Lockheed Martin Solar & Astrophysics Laboratory

Launch and orbit:

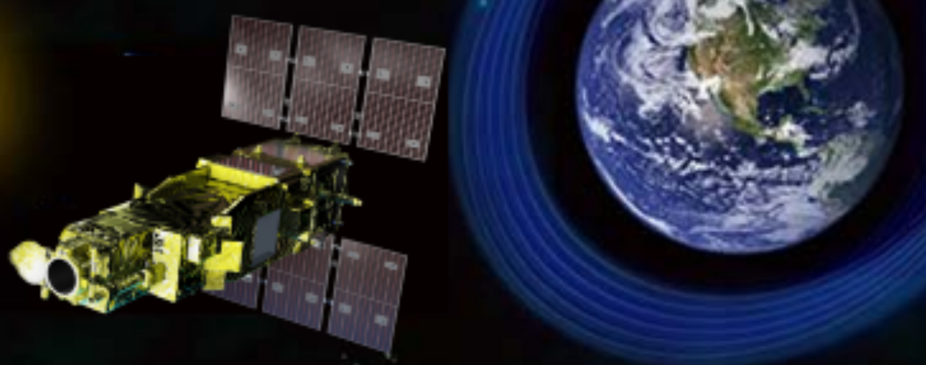
Launch expected early 2027

In May ‘25, MUSE passed CDR

Spectrograph will raster 35 slits across same scene in 3 EUV bands
Context Imager sampling at 304 Å and 195 Å for spatial context

Future Solar Missions – Solar-C

Payload
- EUV High-throughput Spectroscopic Telescope **EUVST**:
  - EUV slit spectrographs: Long-WL and Short-WL camera (~IRIS & Hinode/EIS resp.)
  - Slit-jaw imager for context (~IRIS)
- Solar Spectral Irradiance Monitor **SoSpIM:**
  - solar irradiance in EUV and Ly alpha (<1s cadence)



Main science questions:
- How are the hot corona and solar wind generated?
- When and how do Solar Flares occur?

How to address those:
- Seamless temperature coverage from 10,000 K to 15 million K
- High spatial (0.4”) and temporal (1 sec) resolution
- Velocity resolution of 2 km/s

Very complementary to MUSE

Launch and orbit:
Launch scheduled ~2030
Orbit: Sun-synchronous LEO

Future Solar Wind Missions – SMILE

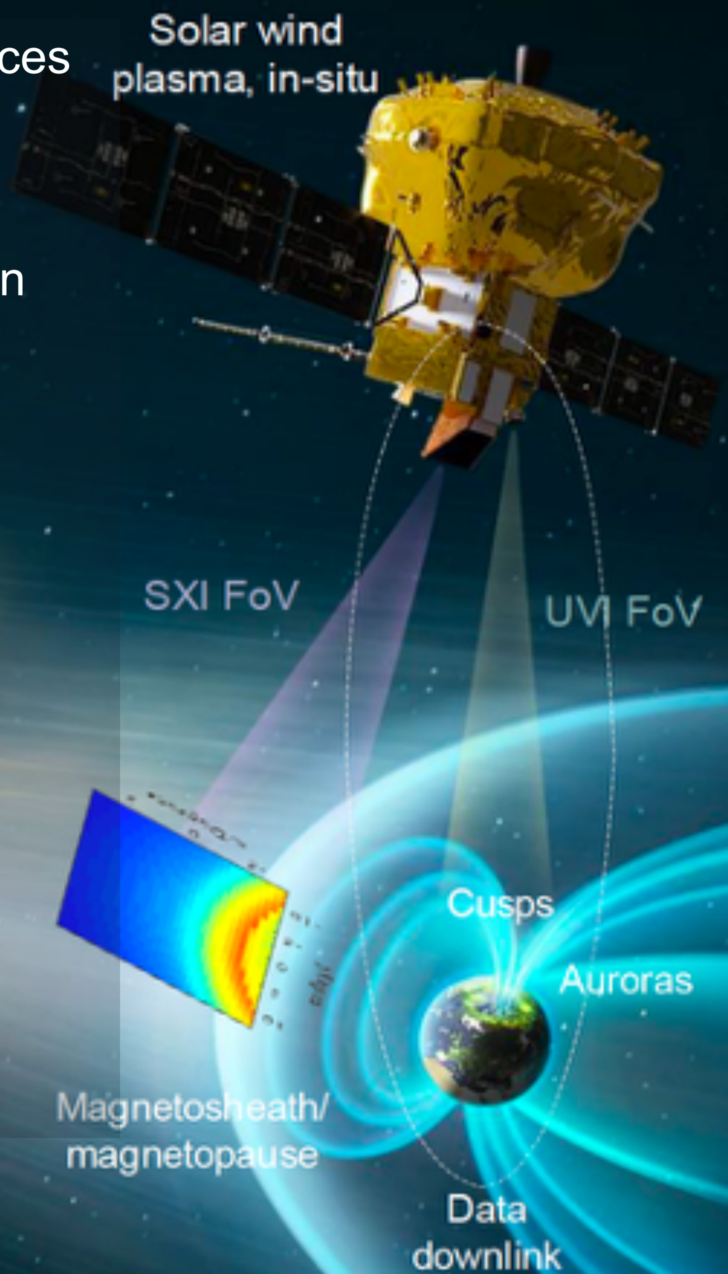
Collaboration ESA & Chinese Academy of Sciences

Main science goal:

complete understanding of Sun–Earth connection by measuring the solar wind and its dynamic interaction with Earth's magnetosphere.

How to address those:

- Measure & image solar wind and magnetosheath plasma
- Observe cusp, magnetopause and magnetosheath for first time in soft X-rays
- Resume auroral imaging after termination IMAGE and Polar operations 15 yrs ago



Payload:

LIA Light Ion Analyser
5 eV-20 keV
4 π FOV

MAG flux-gate magnetometer
B measured up to 40 Hz

SXI X-ray imager
wide FOV 16 x 27º

UVI UV imager
155-175 nm, 10º FOV

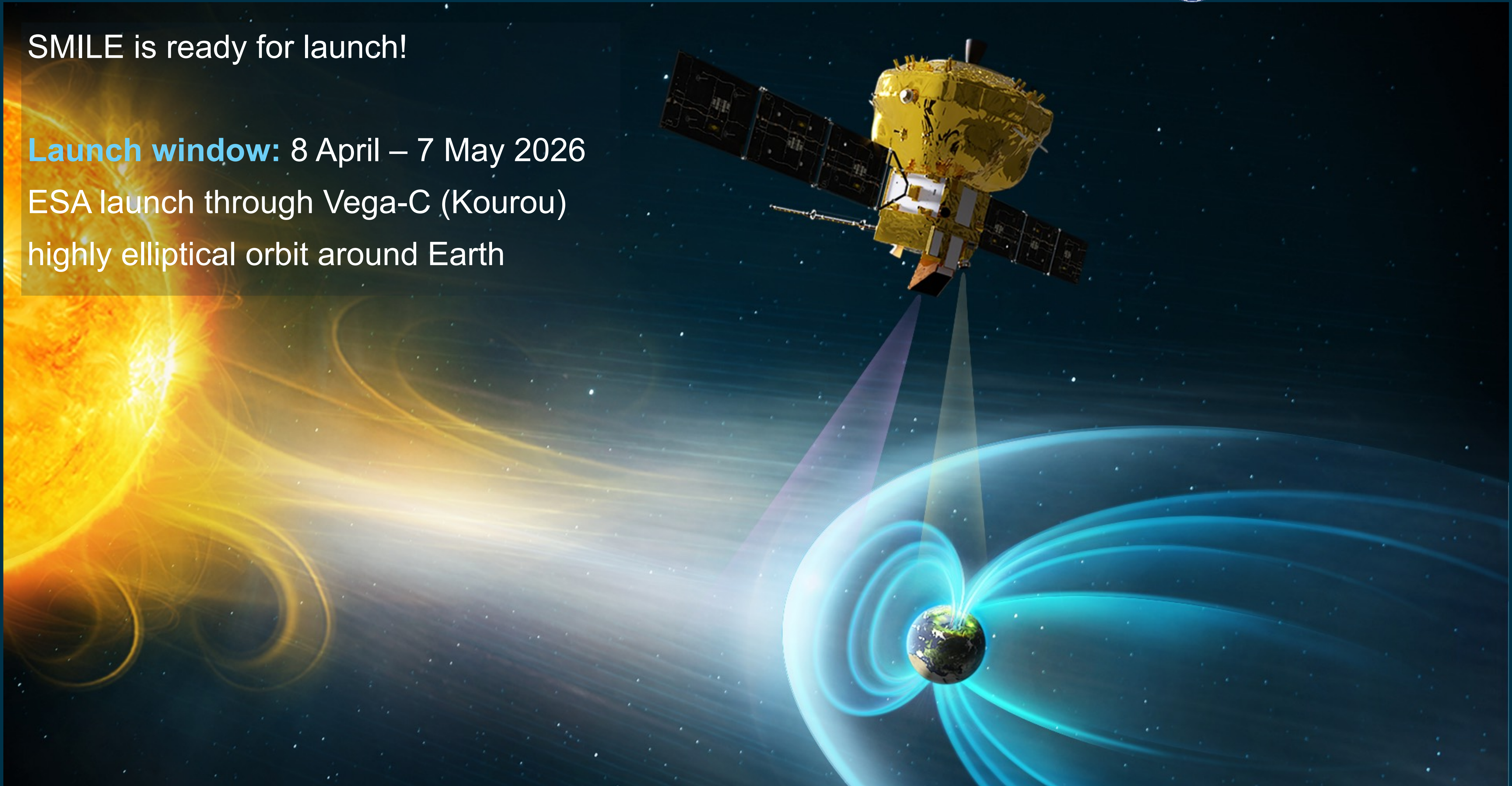
Future Solar Wind Missions – SMILE

SMILE is ready for launch!

Launch window: 8 April – 7 May 2026

ESA launch through Vega-C (Kourou)

highly elliptical orbit around Earth



Future Space Weather missions – SWFO-L1

SWFO-L1 = Space Weather Follow On - Lagrange 1

NOAA/NASA mission

Coronagraph CCOR-2 is considered the successor of LASCO for space weather

Launched September 24, 2025

Arrives at L1 in January 2026, expects to be operational mid 2026.

Full data product validation expected in 2027, after cross-calibration with LASCO

Coronagraph data will be on Earth within 30 mins

In situ data will be available within 5 minutes

- Solar Wind Plasma Sensor (SWiPS),
- SupraThermal Ion Sensor (STIS),
- Magnetometer (MAG)

Future Space Weather missions – Vigil

ESA space weather mission at L5

- Early warning of emerging solar weather conditions
- Forecast up to 4/5 days in advance
- Nowcasting through LowLatency data
- Improved predictions of CME impact time & location

Payload

- Compact coronagraph **CCOR-3**
- Heliospheric Imager **HI**
- Photospheric Magnetic field Imager **PMI**
- EUV Imager **JEDI**
- Plasma Analyser **PLA**
- Magnetometer **MAG**

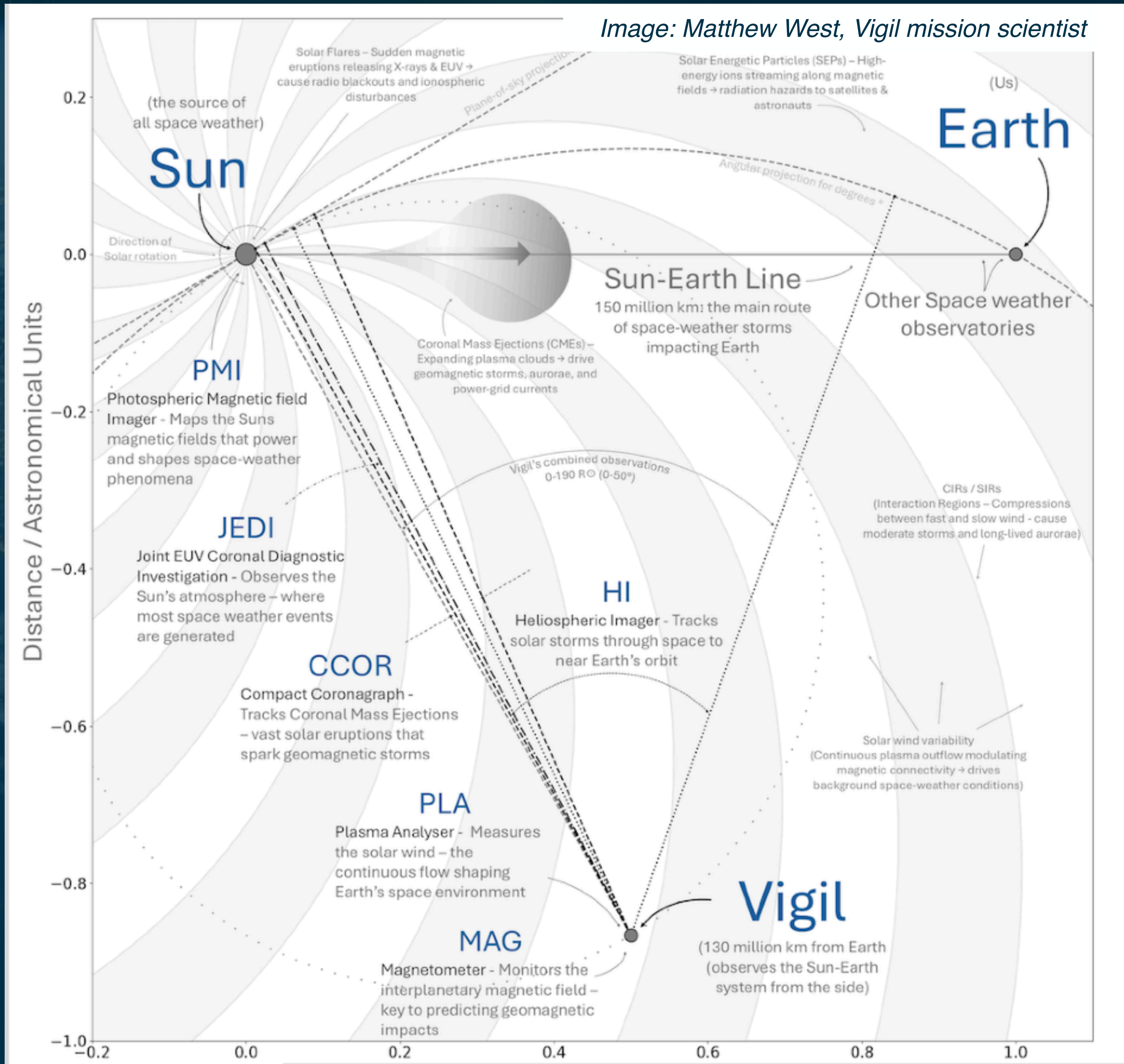
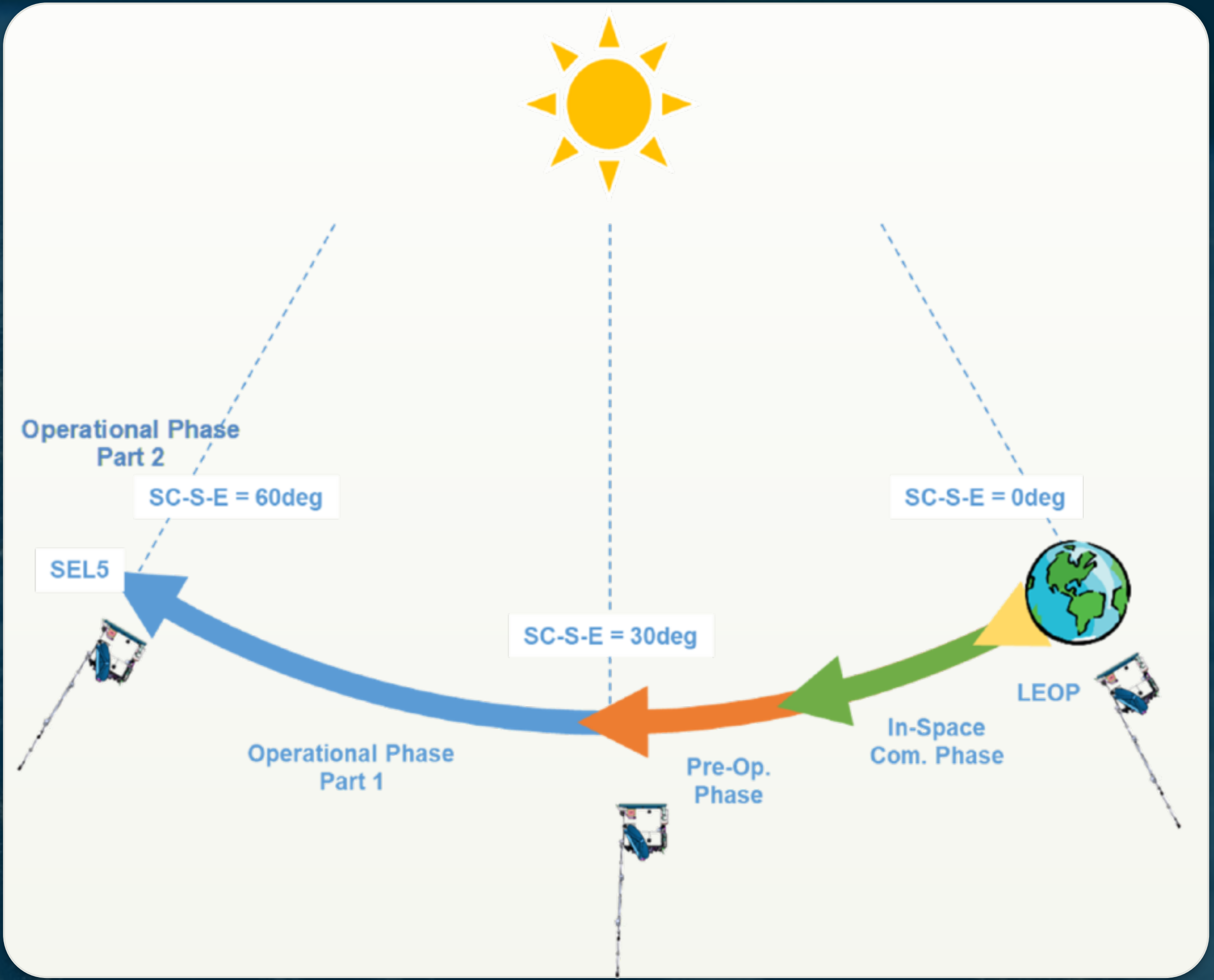


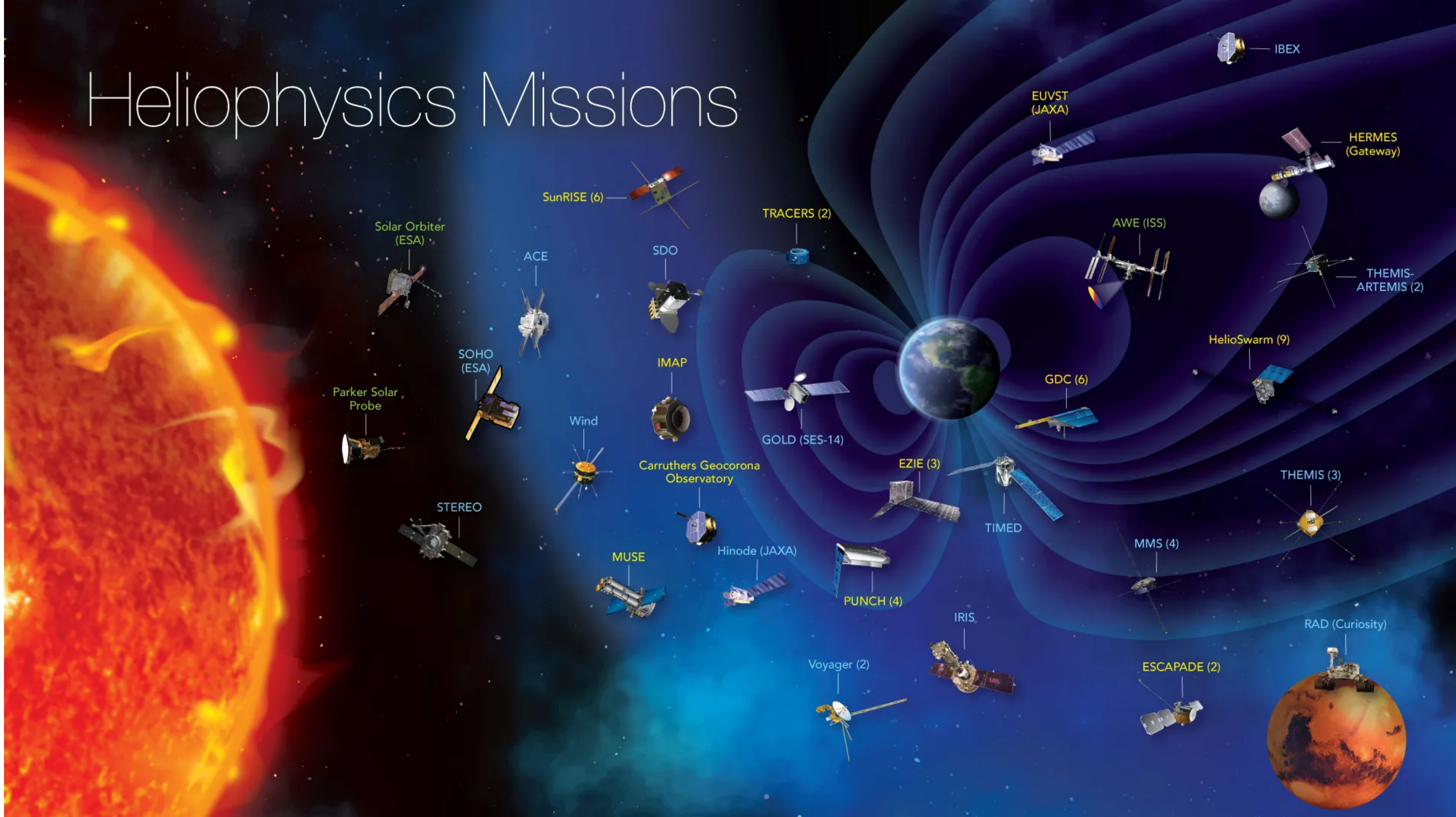
Image: Matthew West, Vigil mission scientist

Future Space Weather missions – Vigil

Mission timeline

- Launch scheduled for **Q3 2031**
- Transfer to L5 expected to last 3 years
- Operational phase can start at 30º separation from Earth





Heliophysics Missions
SunRISE (6)
Solar Orbiter (ESA)
ACE
SDO
TRACERS (2)
EUVST (JAXA)
IBEX
HERMES (Gateway)
AWE (ISS)
THEMIS-ARTEMIS (2)
SOHO (ESA)
Parker Solar Probe
IMAP
Wind
GOLD (SES-14)
GDC (6)
HelioSwarm (9)
Carruthers Geocorona Observatory
EZIE (3)
TIMED
THEMIS (3)
STEREO
MUSE
Hinode (JAXA)
PUNCH (4)
MMS (4)
IRIS
Voyager (2)
ESCAPADE (2)
RAD (Curiosity)