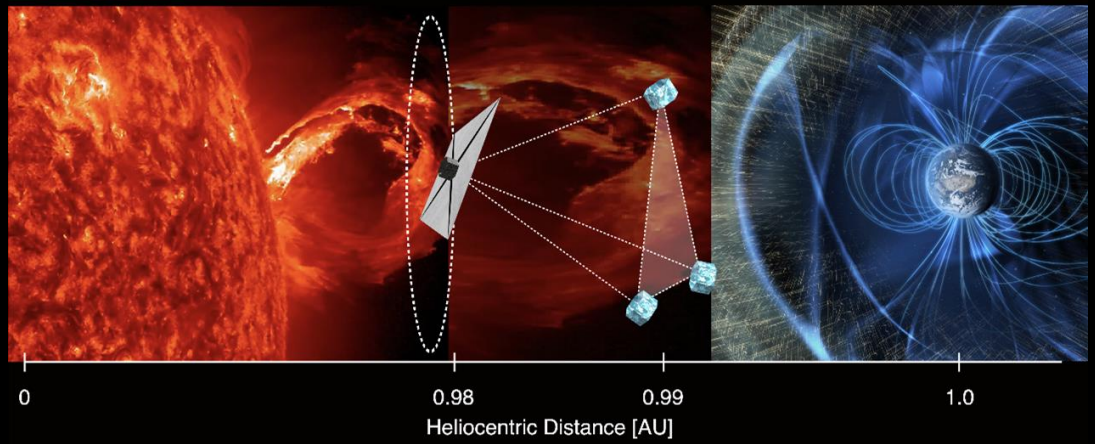
ROSES 2022 - B10. Heliophysics Flight Opportunities Studies (HFOS)

SPACE WEATHER INVESTIGATION FRONTIER (SWIFT)

To unravel the three-dimensional structures and dynamics of extreme space weather phenomena



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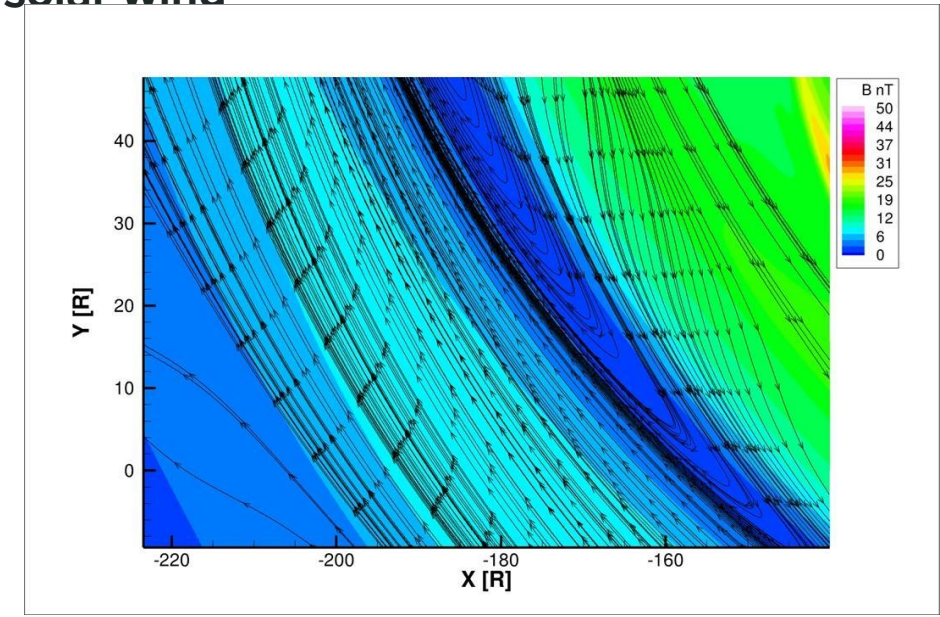
Geo-Effective Solar Wind Structures

★ **Small- to meso-scale structures in the solar wind**

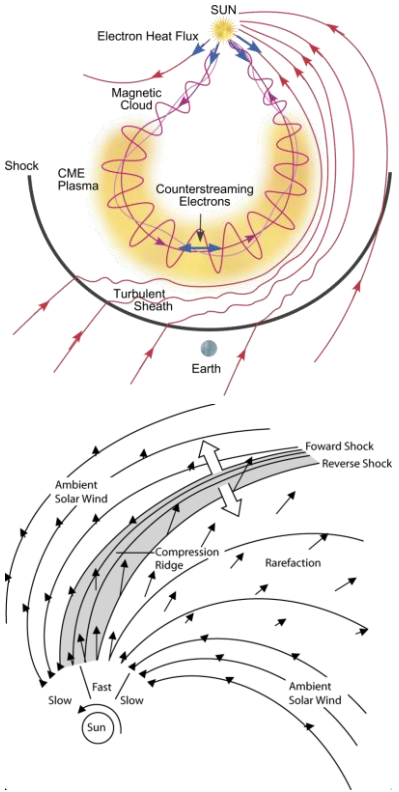
- Density blobs and flux ropes
  - Scale: 5-10,000 RS
  - Transit times: few seconds to hours
  - Periodicity: 1-20 hours
- Heliospheric current sheet (HCS)
  - Very thin: fraction of RS
  - Magnetic reconnection within HCS
- Heliospheric plasma sheet (HPS)
- Turbulence



(Manchester et al.; in preparation)

Geo-Effective Solar Wind Structures

- ★ **Macro-scale structures in the solar wind**
  - Interplanetary Coronal Mass Ejection (ICME)
    - Scale: hundreds of RS (Ala-Lahti+ 2023; Soni+ 2023)
    - Frequency: 10-40 per year (Jian+ 2018)
  - Stream Interaction region (SIR)
    - Frequency: 2-4 per month (Jian+ 2006)
  - Interplanetary shocks (ISs)
    - Frequency: 1 per month (Jian+ 2006)

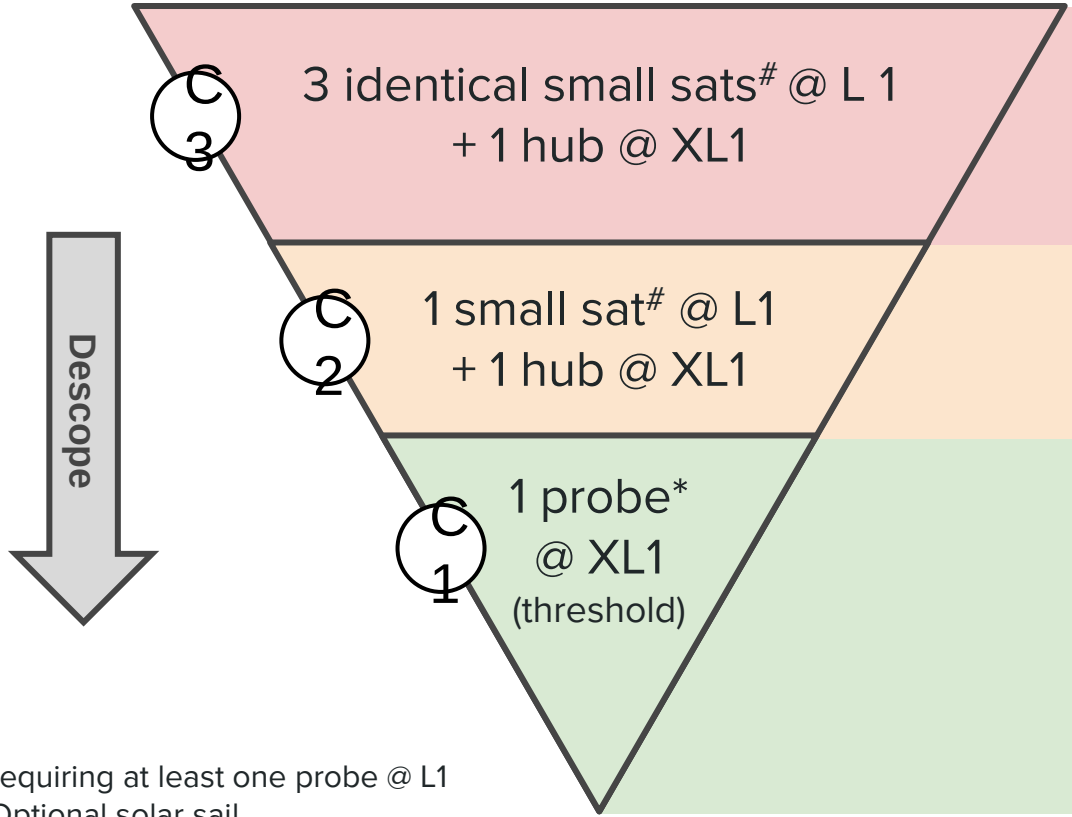


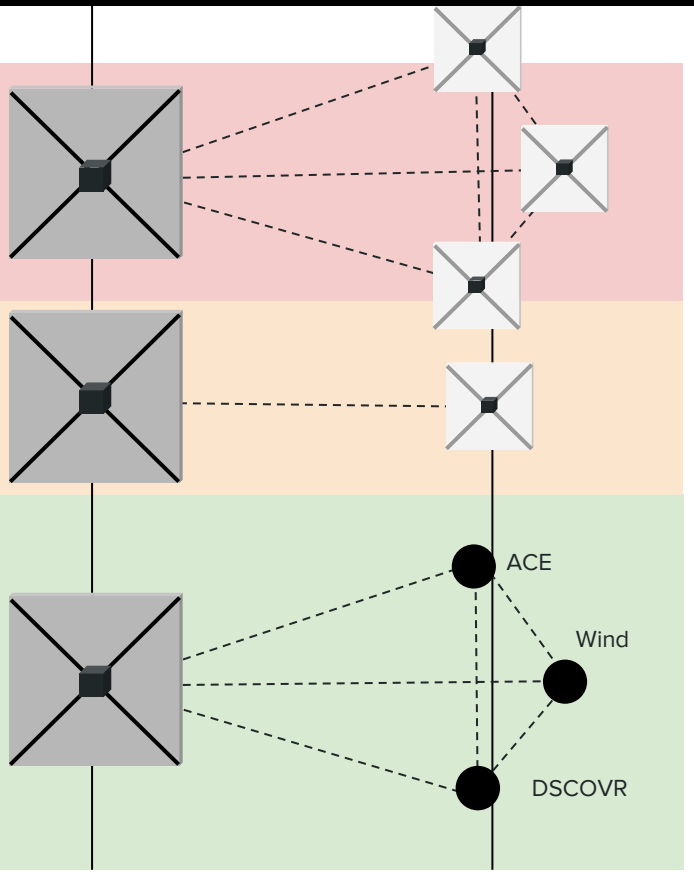
Zurbuchen+ 2006; Jian+ 2006

- ★ Multiple probes sampling the upstream solar wind
  - **Resolve the 3D structure** of small- to meso-scale solar wind structures along the Sun-Earth-line,
  - **Complement WIND, ACE, and DSCOVR** (and **IMAP**), by providing upstream measurements for investigating the temporal evolution of solar wind structures, and
  - **Increase lead time** of space weather forecasts from L1 observatories **by 35%**
- ★ Solar sail (**TRL=6**) **UNIQUELY** enables:
  - **Affordable** orbit insertion, and
  - **Long-duration** attitude control, allowing to “park” at a desired location.
- ★ The science objective is important to both NASA & NOAA, and addresses space weather goals set by the decadal survey.

Science Objective: to determine whether local or global processes drive geo-effective solar wind structures

Constellation Configurations





Sub-L1

* Requiring at least one probe @ L1
\# Optional solar sail

SWIFT Constellation

1 “hub” @ sub-L1

- Solar sail propulsion
- Lissajous orbit

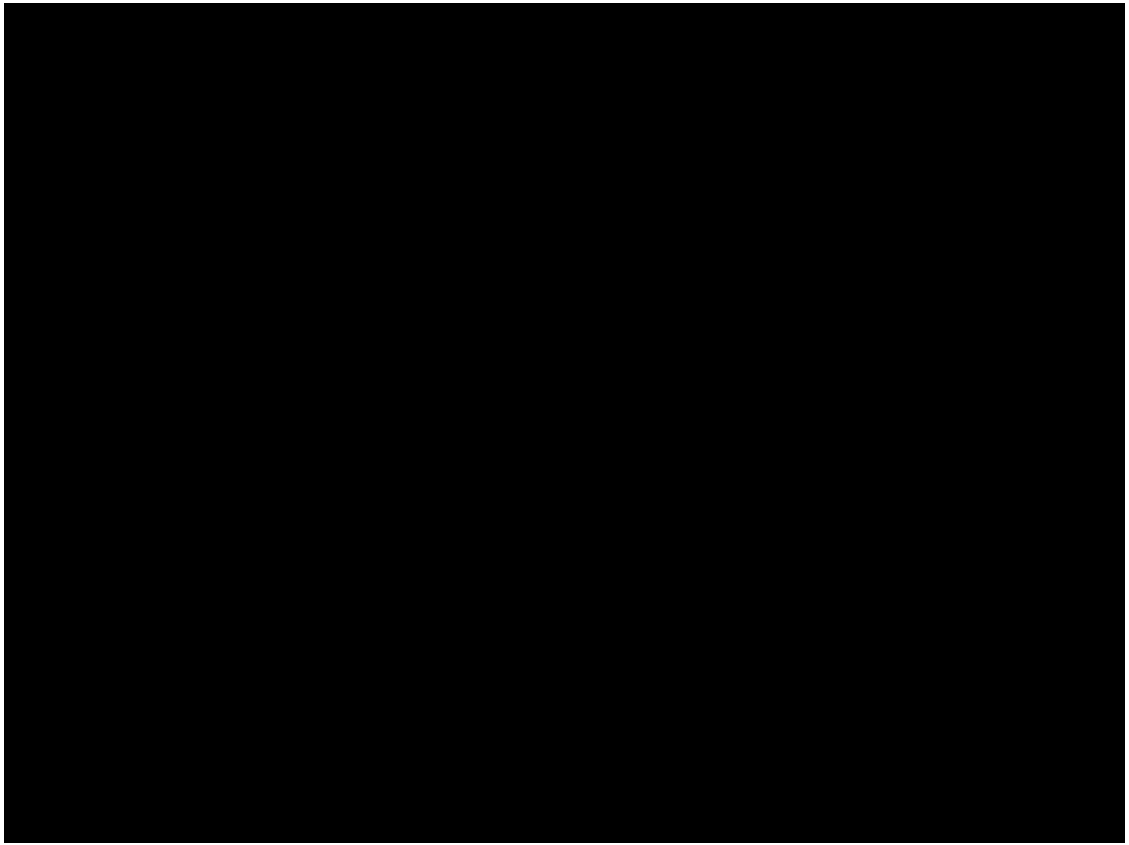
3 identical “nodes” @ L1

- Chemical propulsion
- 3 independent halo orbits

S/C separation < **1 RS**

Tetrahedron Quality Factor Q ranges between 0 and 1, where 1 is ideal –all sides equal, most reliable for 3D analyses.

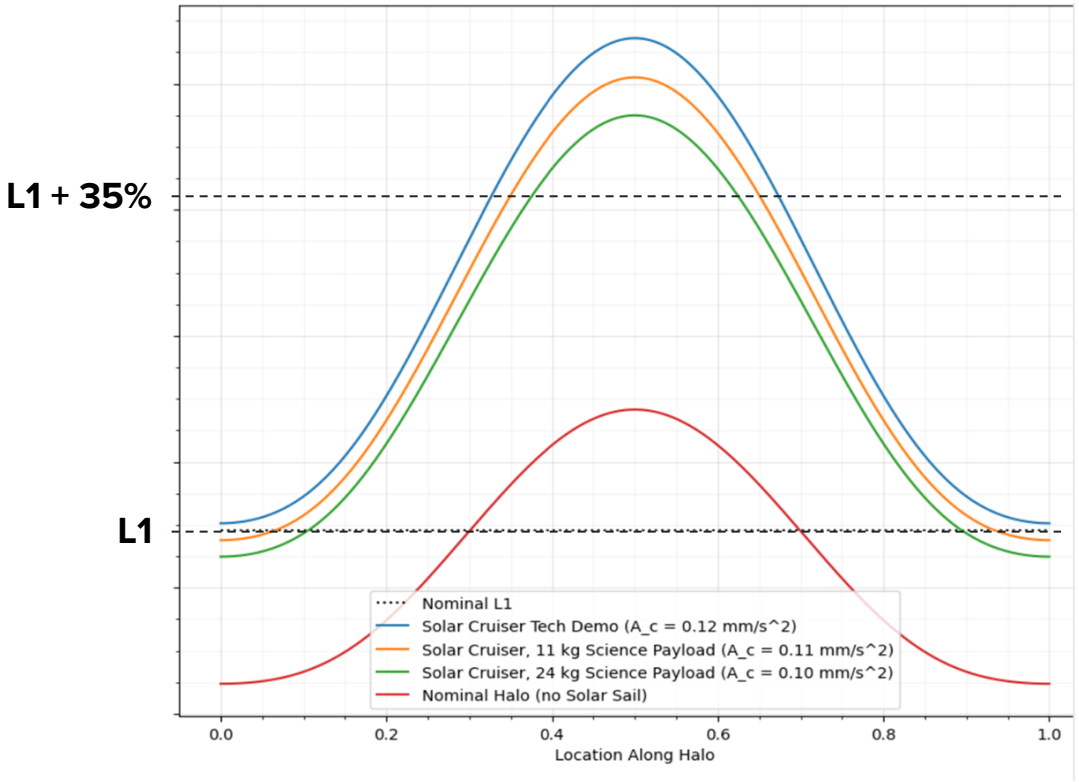
- SWIFT: Avg **Q = 0.605**



Science Payload

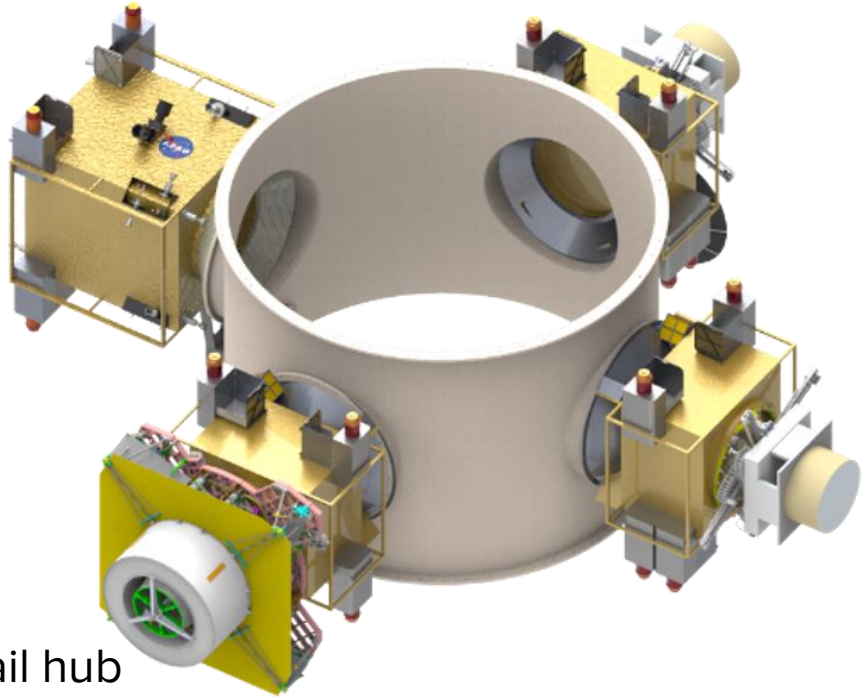
- Two magnetometers
- Plasma Instruments
  - Two ion and two electron heads
- Ion Composition Instrument

Total Mass = 19.6 kg



Stowed Design (ESPA Grande)

Chemical node



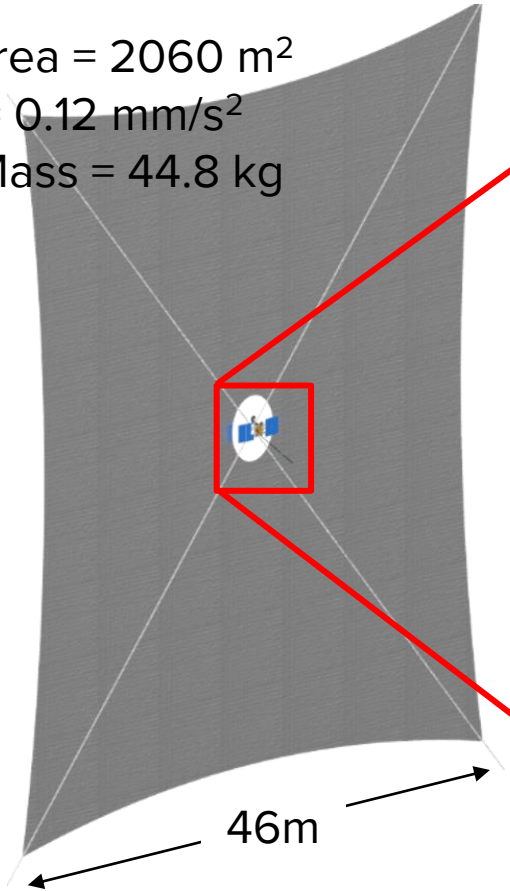
Sail hub

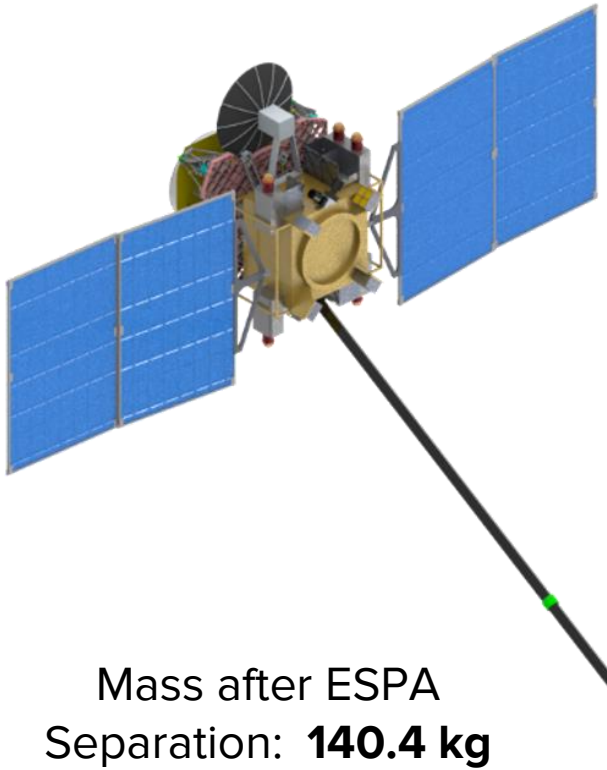
Sail Hub @ sub-L1

Sail Area = 2060 m^2

a_c = 0.12 mm/s^2

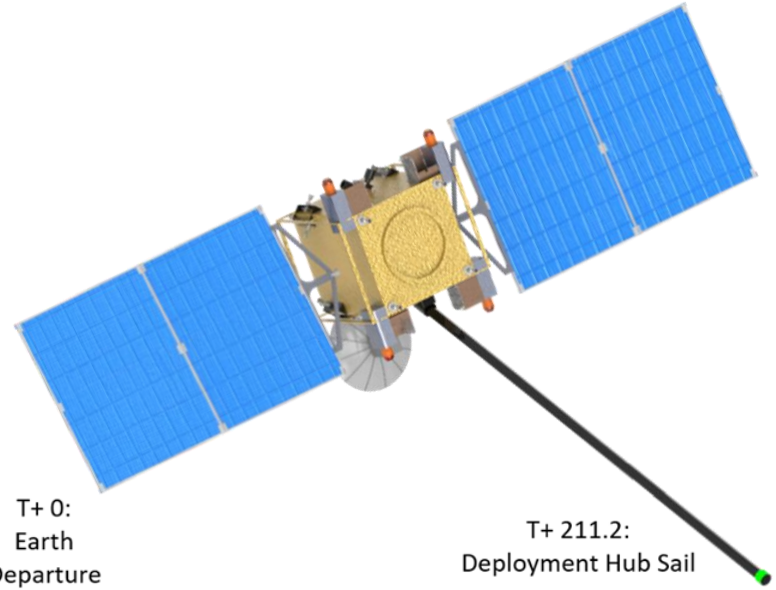
Sail Mass = 44.8 kg





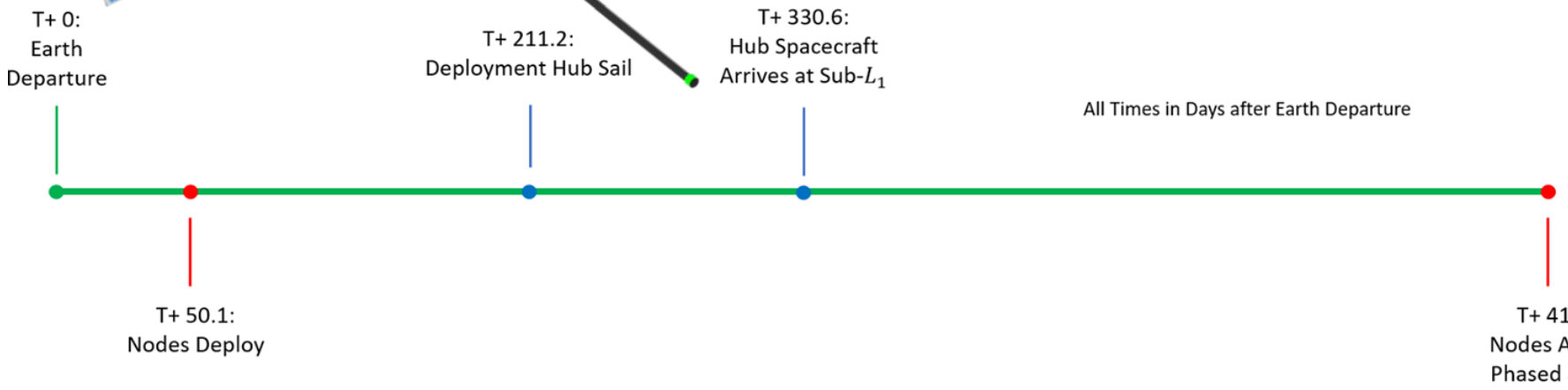
Mass after ESPA Separation: **140.4 kg**

Chemical Node(s) @ L1



DV = 495 m/s
Total Propellant = 30.1 kg

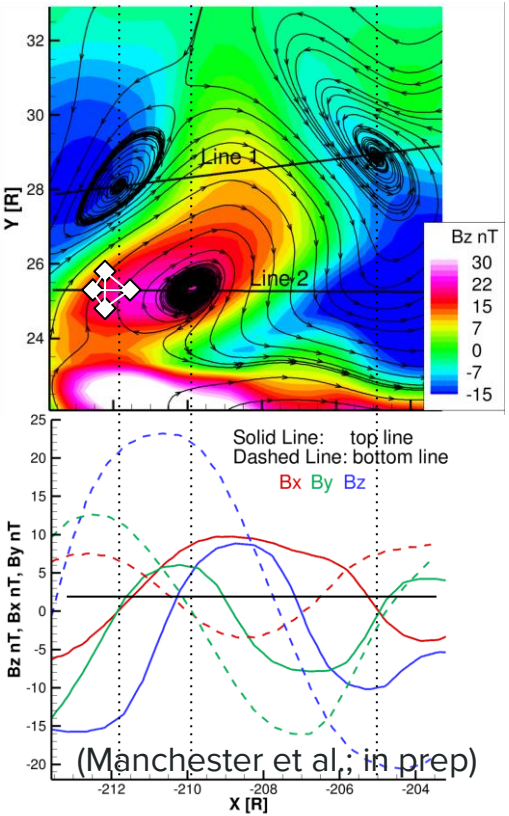
Mass after ESPA Separation: **127.8 kg**



Summary

★ One sailcraft hub at sub-L1 and three nodes at L1

- **Resolve the 3D structure and dynamics** of geo-effective, small- to macro-scale solar wind structures along the Sun-Earth-line,
- **Increase lead time** of space weather forecasts from L1 observatories **by 35%**, aligned with NASA, NOAA & Decadal Survey



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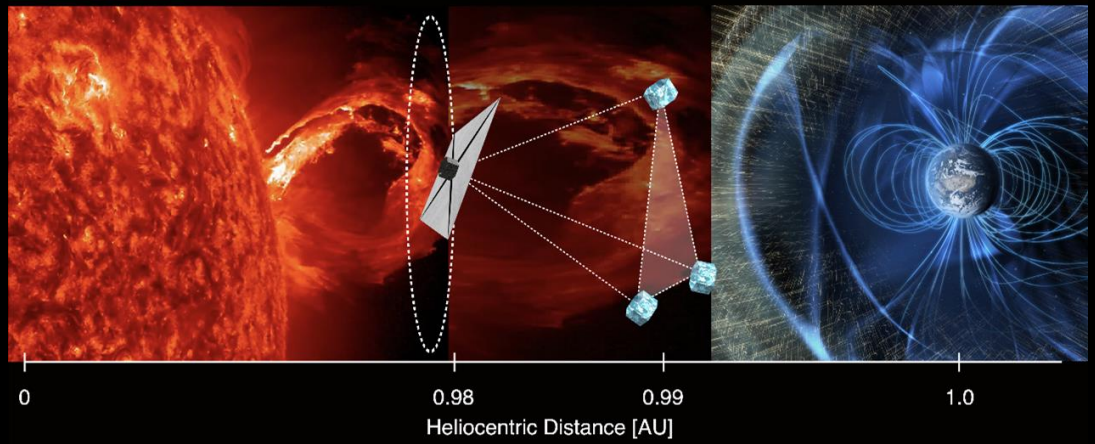

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