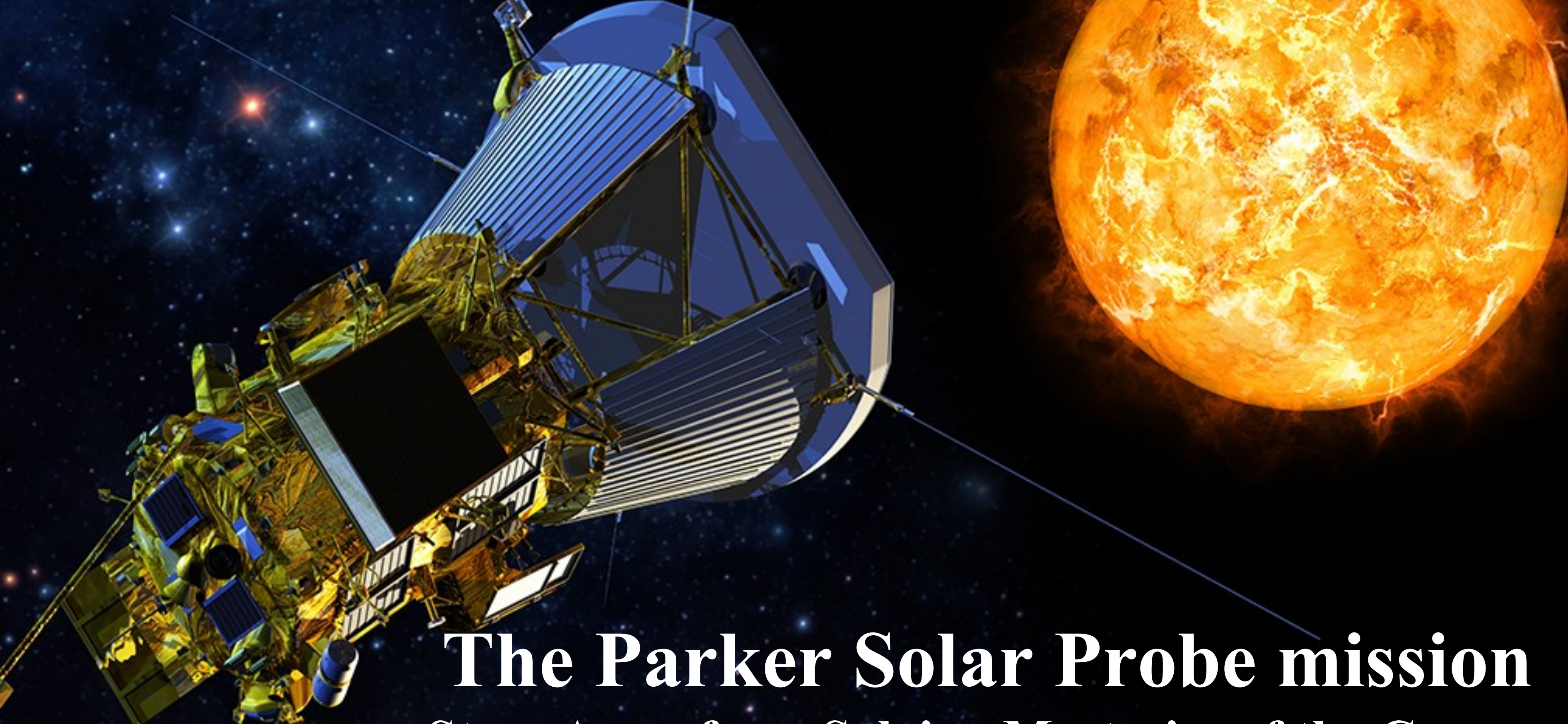
Parker Solar Probe

A NASA Mission to Touch the Sun



The Parker Solar Probe mission

Steps Away from Solving Mysteries of the Corona and the Inner Heliosphere

Nour E. Raouafi

NASA

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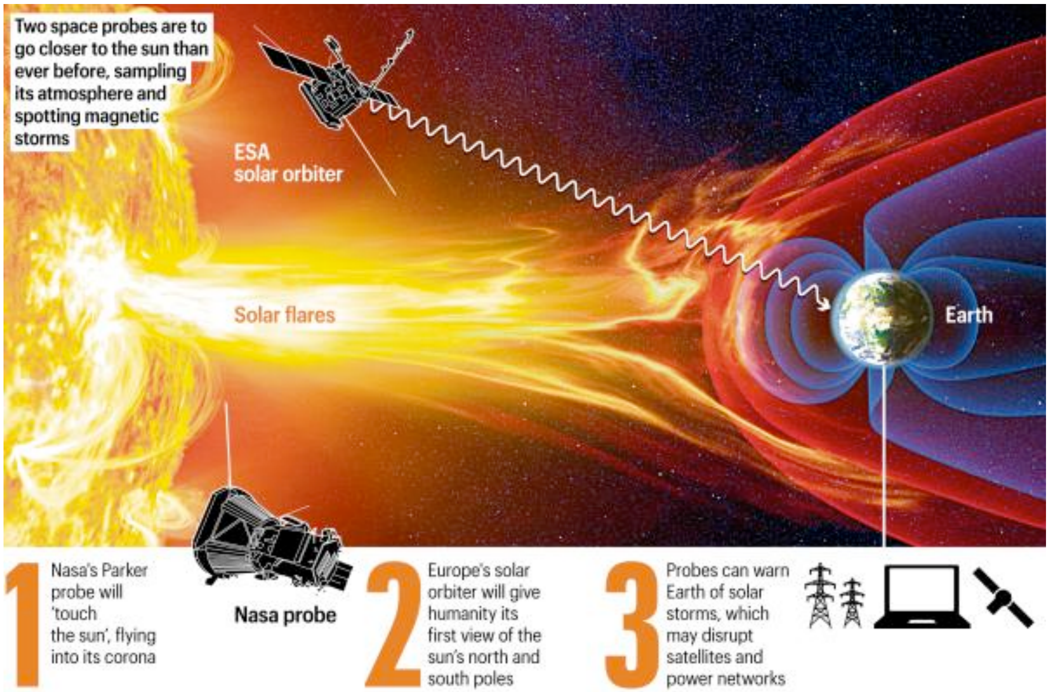
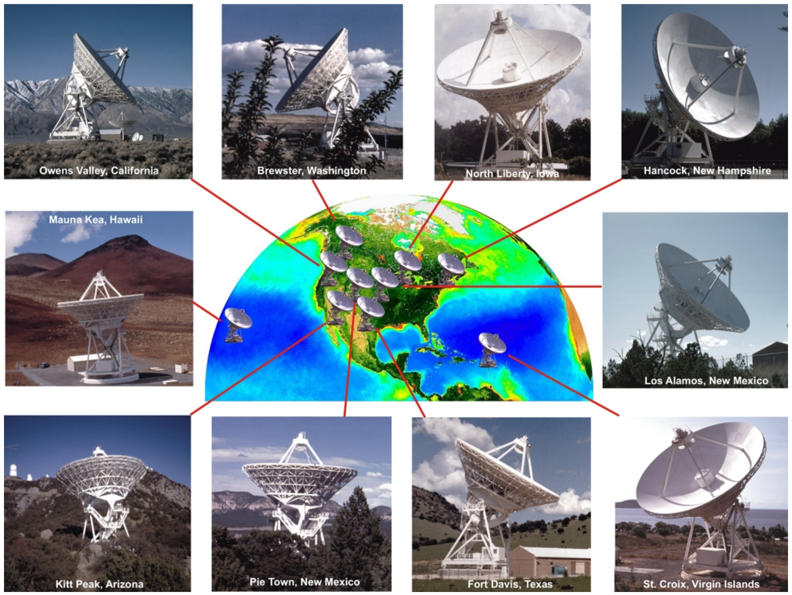
2000s: "an Inflection Point" in Solar and Heliospheric Research





Parker Solar Probe: fly through the solar corona

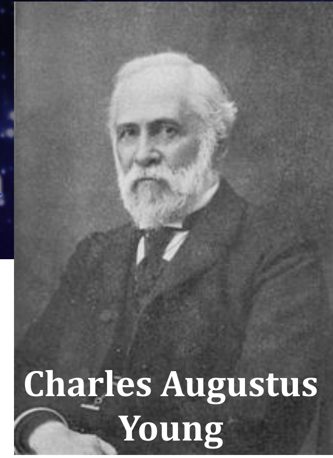
Solar Orbiter: view of the solar poles

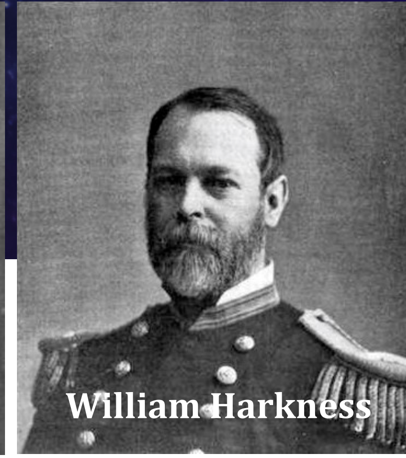
DKIST: access to the building block of solar magnetism

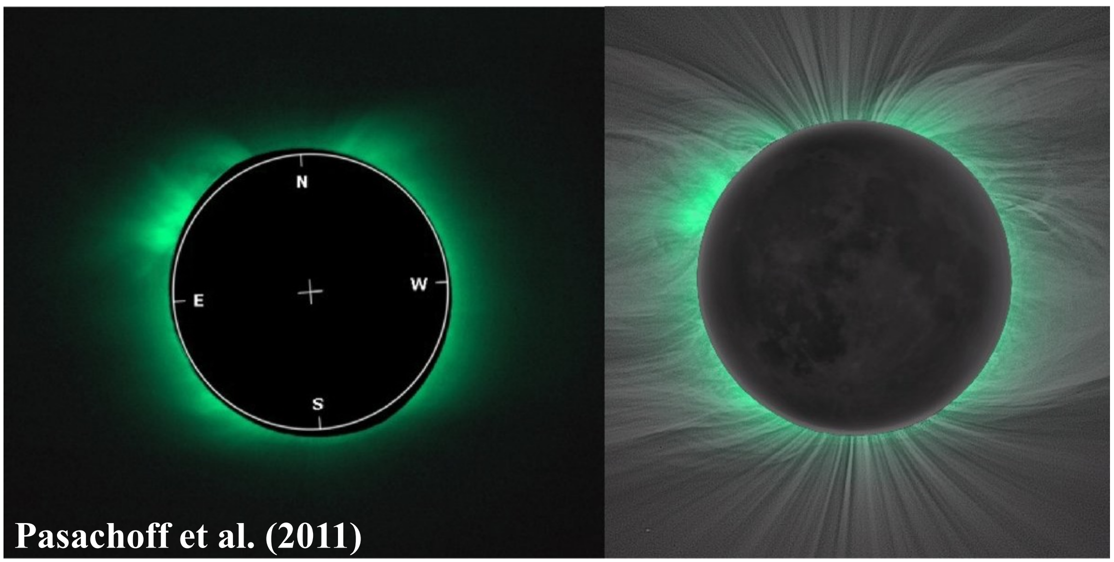
Radio: magnetic fields and solar wind

Eclipse of Aug. 7, 1869

The Beginnings of a Coronal Revolution







Pasachoff et al. (2011)

Observation of a faint emission line at ~ 5303 Å: **The Green Line**

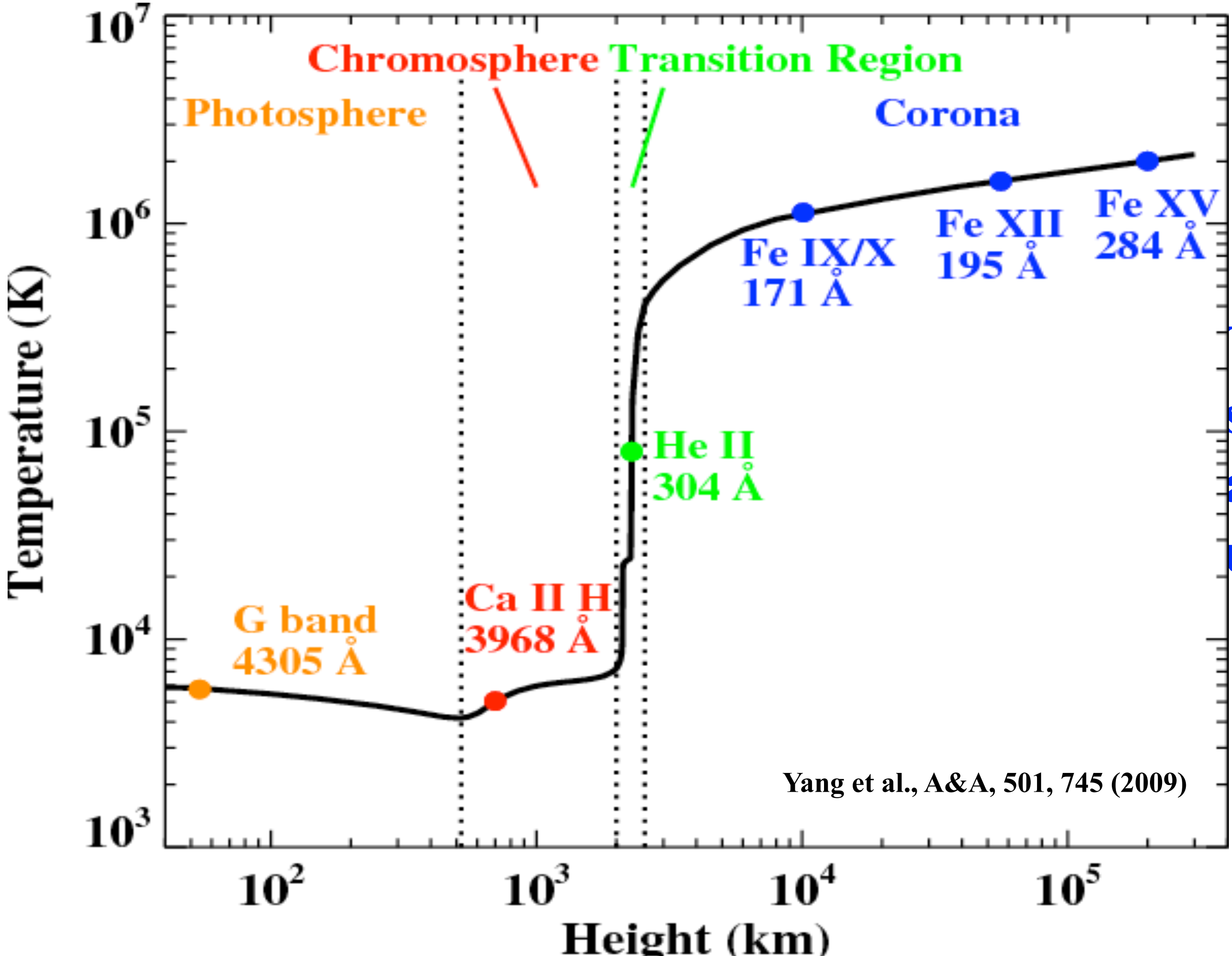
A mystery that lasted for more than seven decades (1869-1941)

The Eureka Moment (Edlén 1941)

It is Fe^{13+}

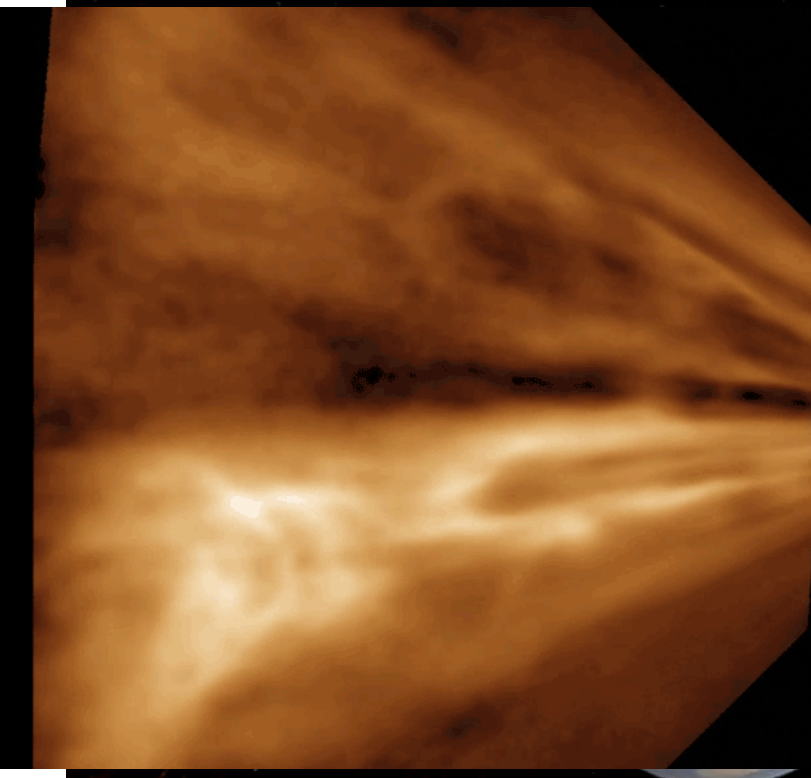
Johns Hopkins Applied Physics Laboratory

The True Nature of the Solar Corona



The solar corona shines in X-rays and extreme ultraviolet (EUV)

The Problem of the Solar Wind Acceleration

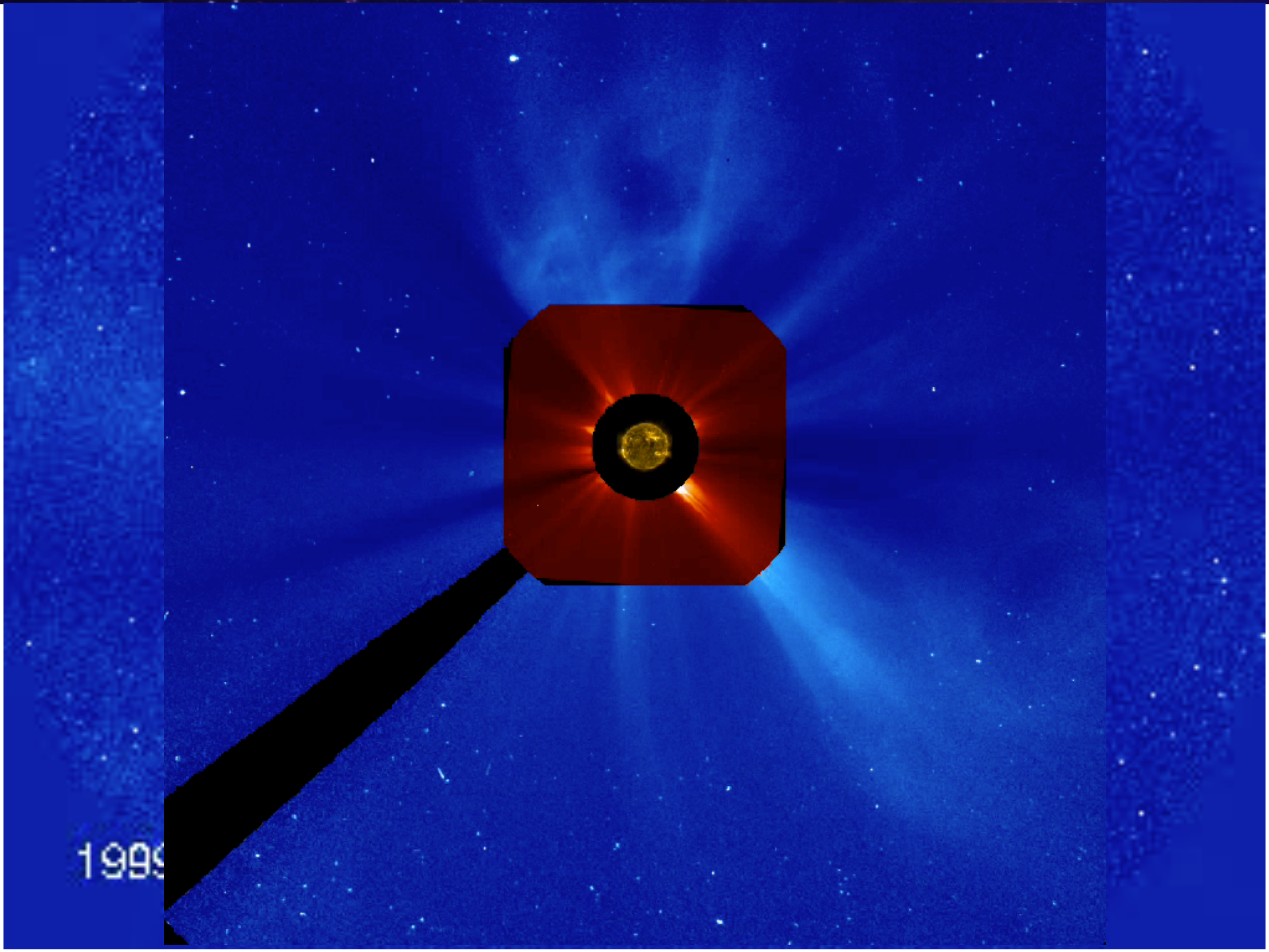


Cou

What accelerates the solar wind so fast?

Credit: NASA

Coronal Magnetic Activity



Touching a Star

A Monumental Stride for Humanity

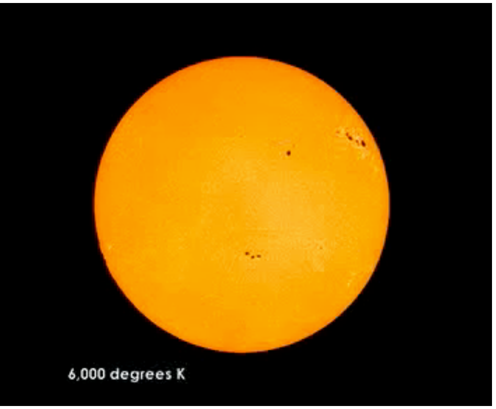
But why do we need to explore the inner atmosphere of the Sun?

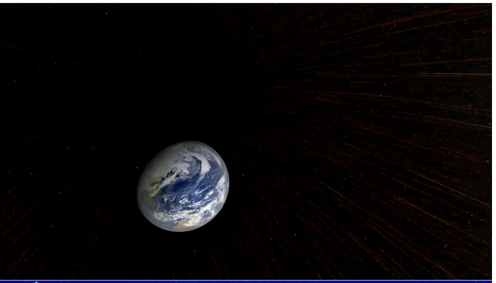
Impact of Coronal Activity on Earth Environment

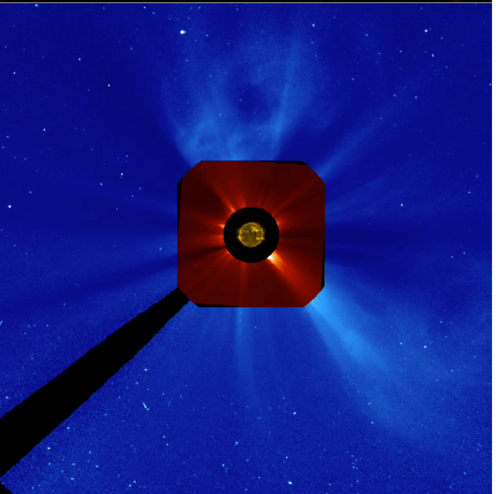
Can we afford to live comfortably without understanding how the solar corona works?

Parker Solar Probe Science

Solving the Mysteries of the Corona & the Inner Heliosphere

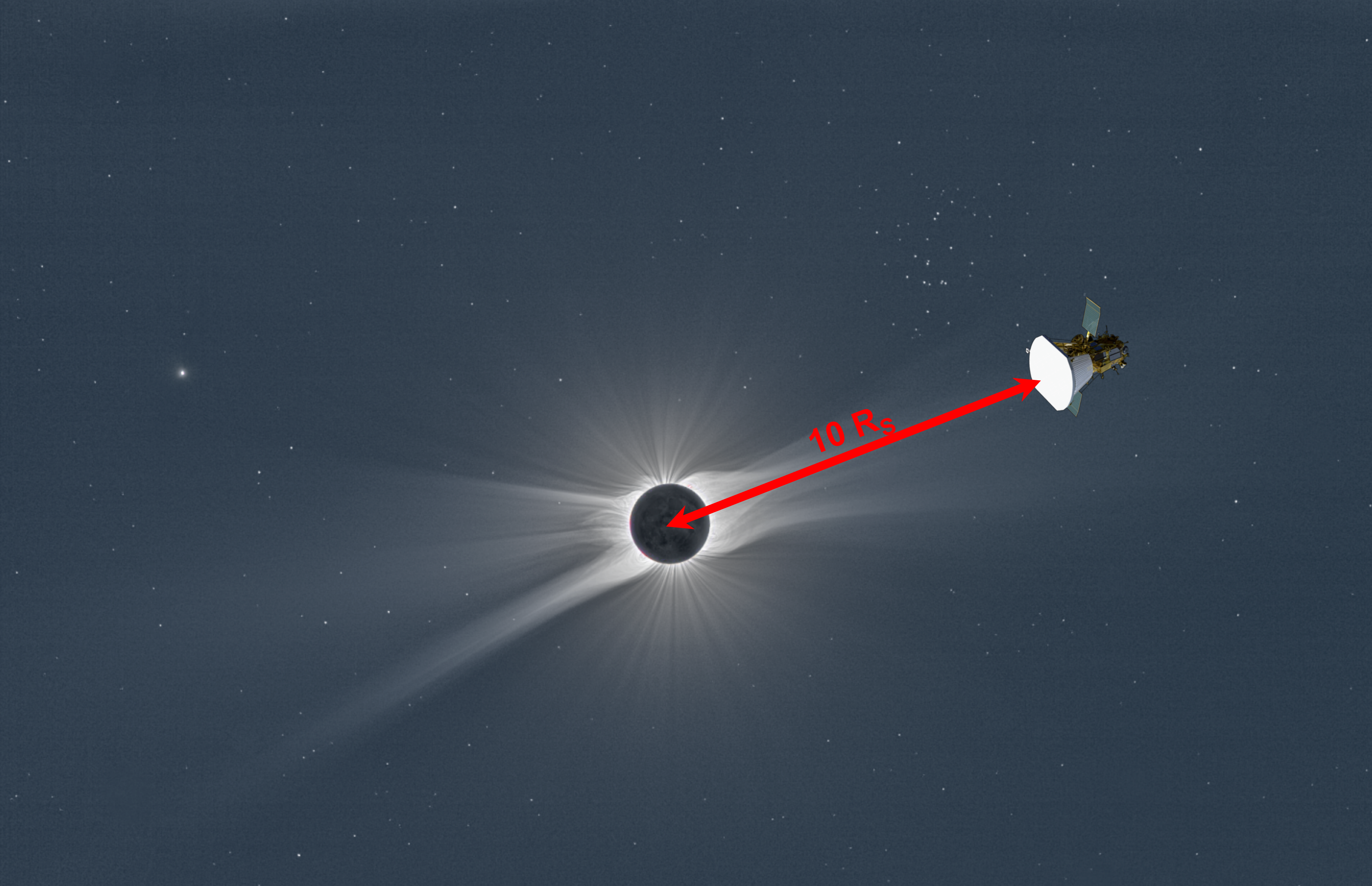






Parker Solar Probe will study how energy flows out of the Sun, why the solar corona is so hot and to what makes the solar wind go so fast.

1. **Trace the flow of energy that heats the solar corona and accelerates the solar wind.**
   - 1a. How is energy from the lower solar atmosphere transferred to, and dissipated in, the corona and solar wind?
   - 1b. What processes shape the non-equilibrium velocity distributions observed throughout the heliosphere?
   - 1c. How do the processes in the corona affect the properties of the solar wind in the heliosphere?
2. **Determine the structure and dynamics of the plasma and magnetic fields at the sources of the solar wind.**
   - 2a. How does the magnetic field in the solar wind source regions connect to the photosphere and the heliosphere?
   - 2b. Are the sources of the solar wind steady or intermittent?
   - 2c. How do the observed structures in the corona evolve into the solar wind?
3. **Explore mechanisms that accelerate and transport energetic particles.**
   - 3a. What are the roles of shocks, reconnection, waves, and turbulence in the acceleration of energetic particles?
   - 3b. What are the source populations and physical conditions necessary for energetic particle acceleration?
   - 3c. How are energetic particles transported in the corona and heliosphere?



PSP will travel to within 4% (below 10 Rs) Sun-Earth distance – well within the portion visible during an eclipse

Parker Solar Probe

Launch & Mission Design Overview

Launch

- Dates: Jul 31 – Aug 19, 2018
- Max. Launch C3: 154 km^2/s^2
- Delta IV-Heavy: the most powerful rocket available today

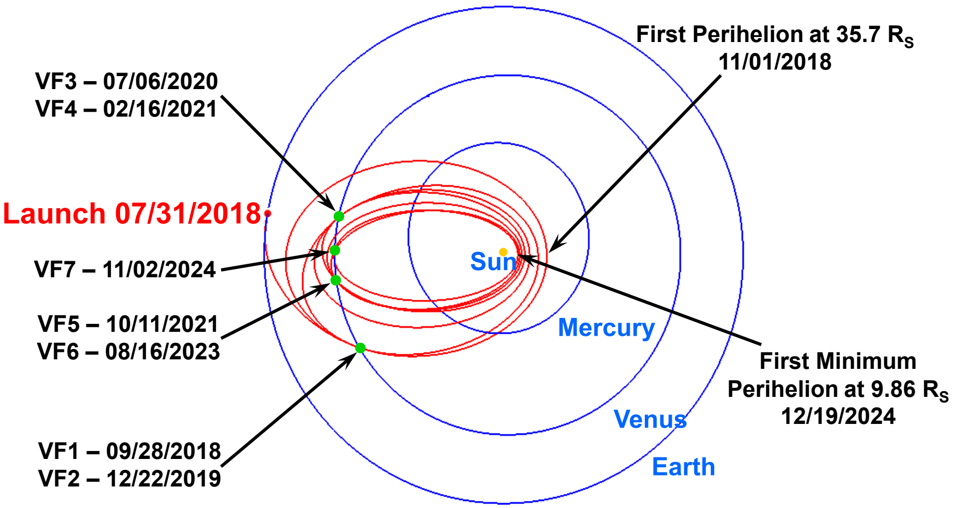
Trajectory Design

- 24 Orbits
- 7 Venus gravity assist flybys

Final Solar Orbits

- Closest approach: 3.83 million miles
- Speed ~450,000 miles per hour
- Orbit period: 88 days

Mission duration: 6 yrs, 11 months



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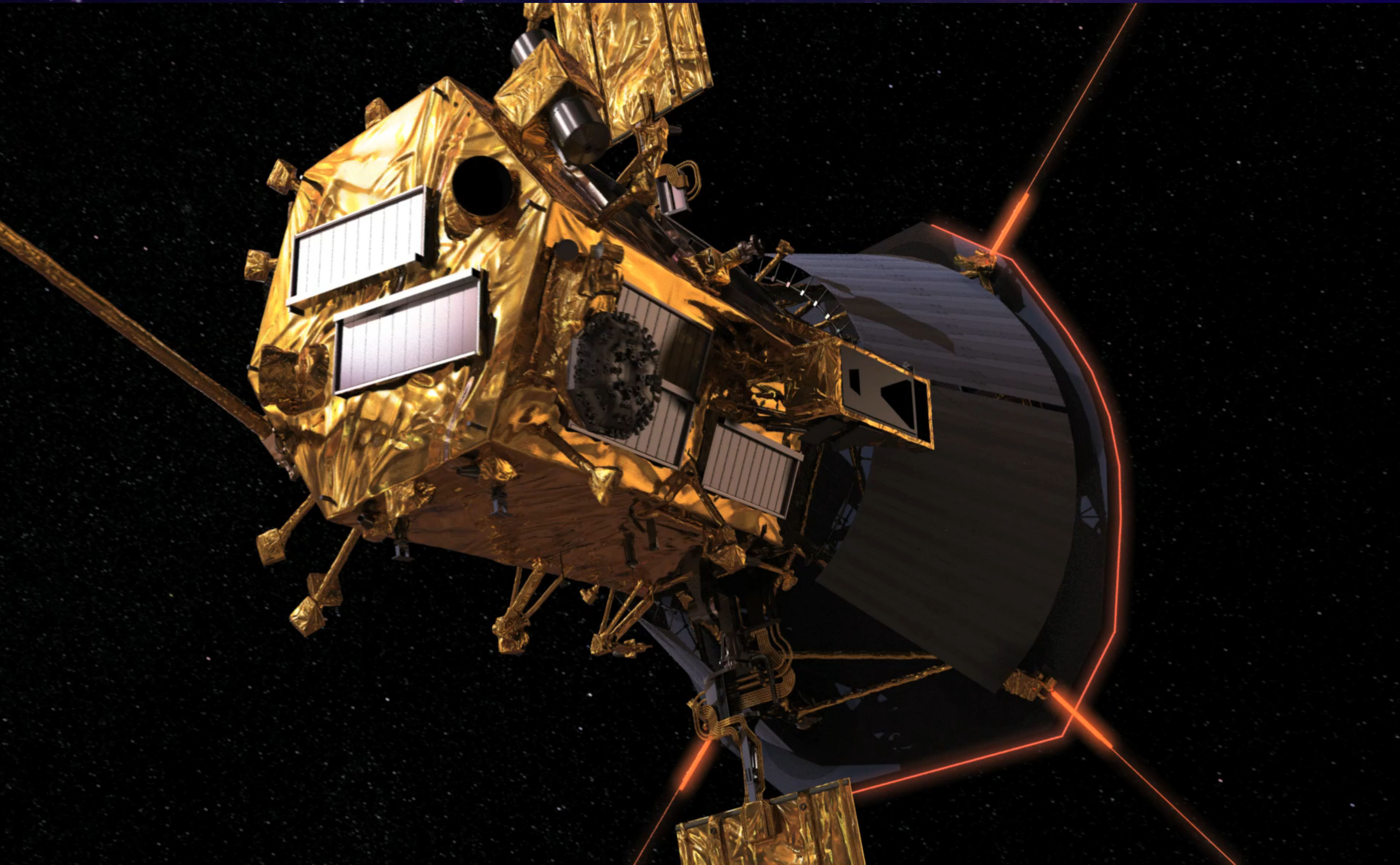
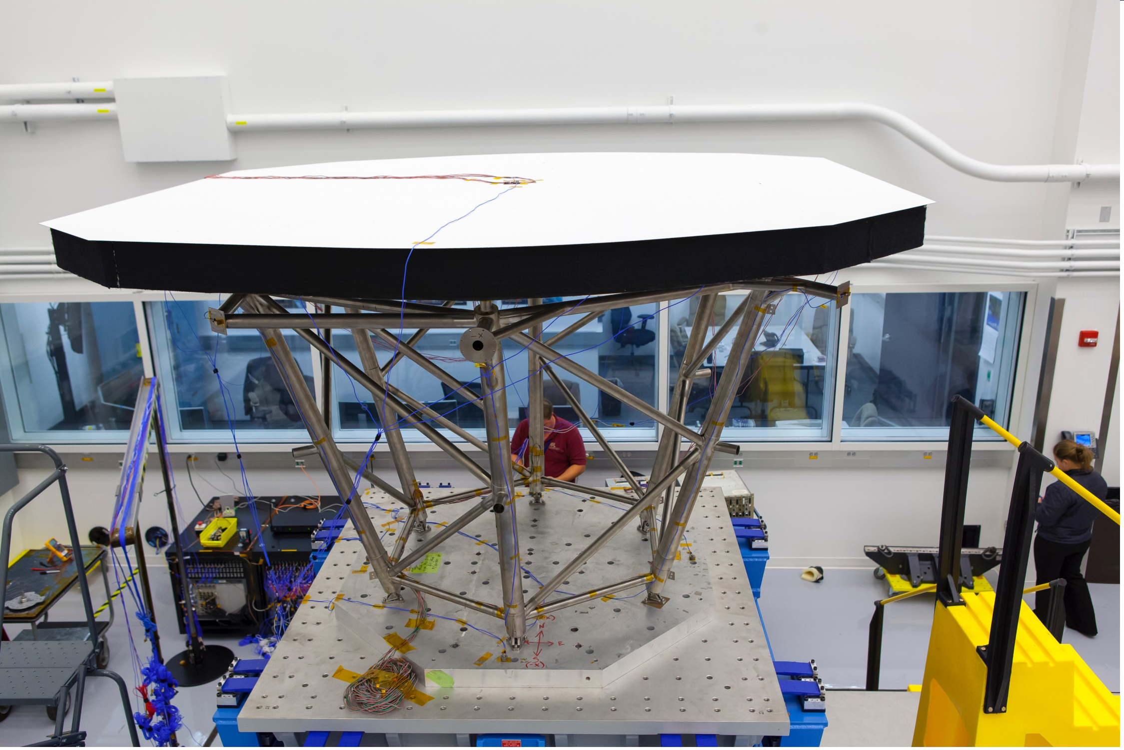
The Parker Solar Probe

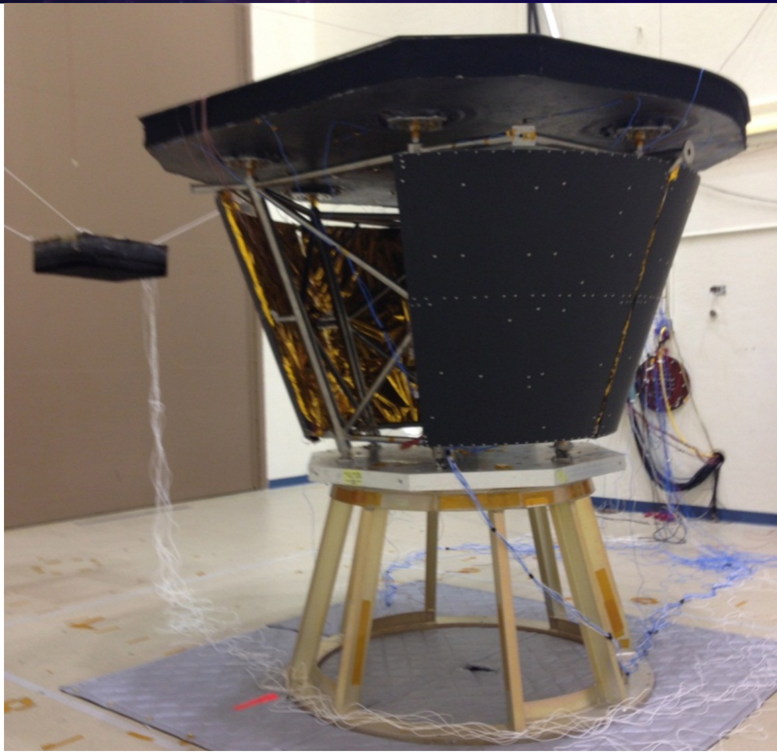
A Mission of Extremes



Parker Solar Probe

Thermal Protection System Assembly





- **4.5-inch-thick (11.43-centimeter-thick) carbon-composite shield**
- **At closest approach, the front the heat shield will be at 2500°F (1,400°C), but the payload will be near room temperature**
- **Water-cooled radiators**

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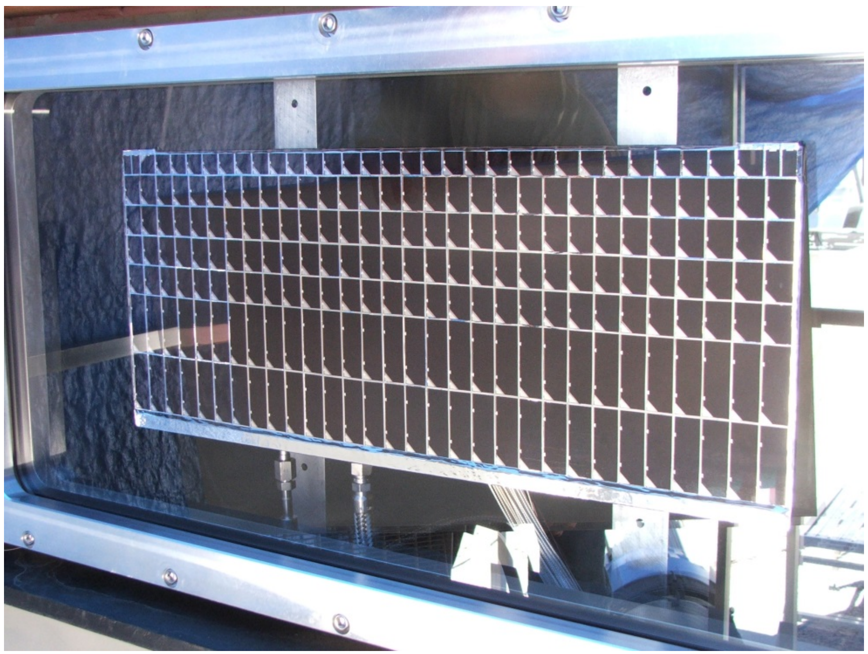
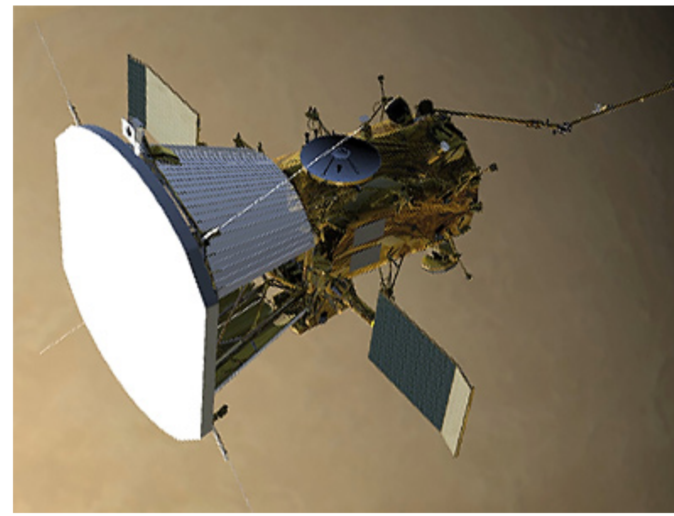
Parker Solar Probe

Solar Arrays

- **Solar Array is unique: liquid cooled, operates under extreme solar flux.**



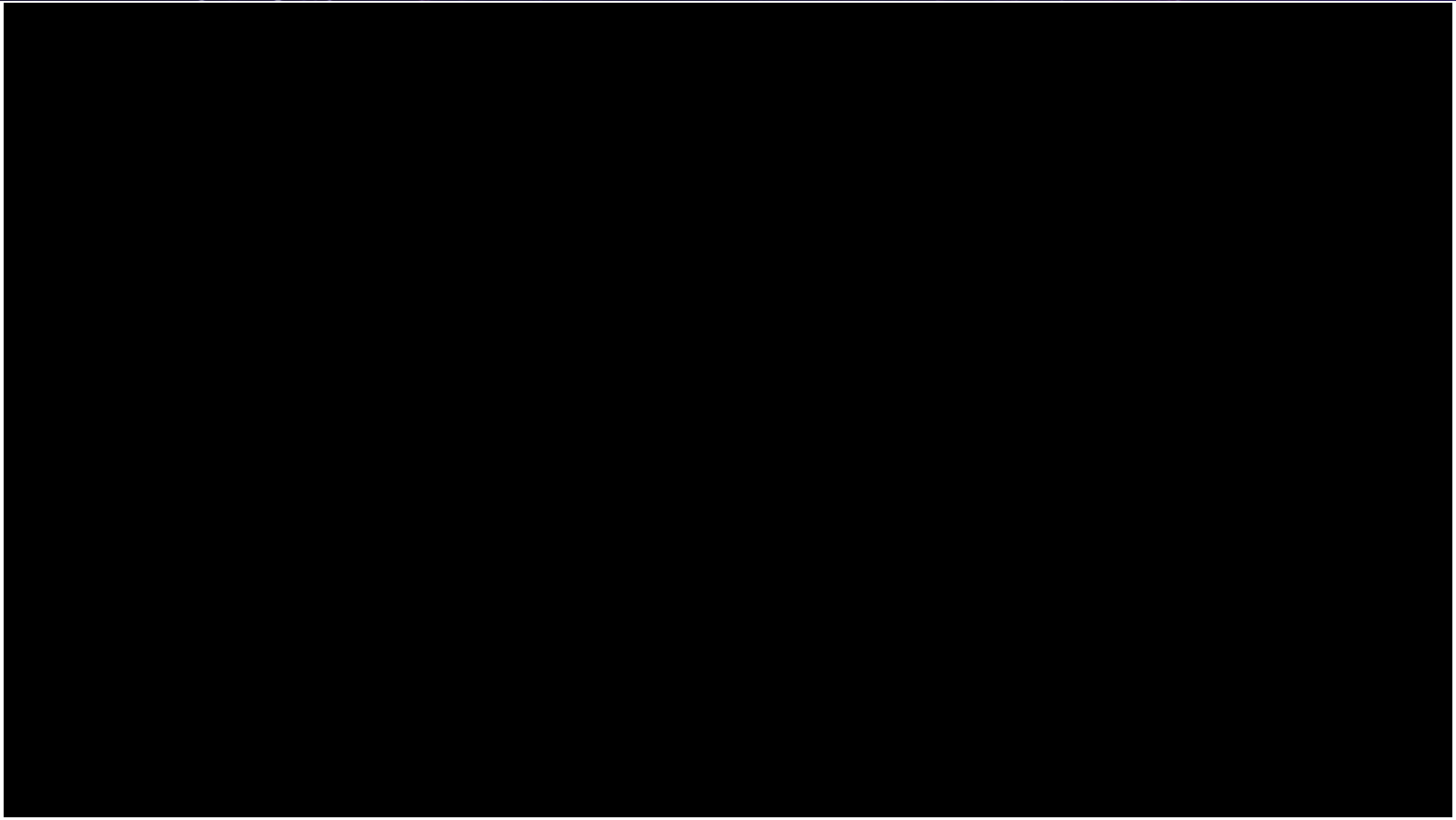
Full Sized Solar Array in Heliostat Vacuum Chamber



Heliostat

J-109 to Parker Solar Probe Launch

Major Mile Stones



- PSP at Goddard: TVAC went well; thermal cycling ongoing
- March 31st: PSP will ship to the Cape – final tests
- July 31st: launch window opens

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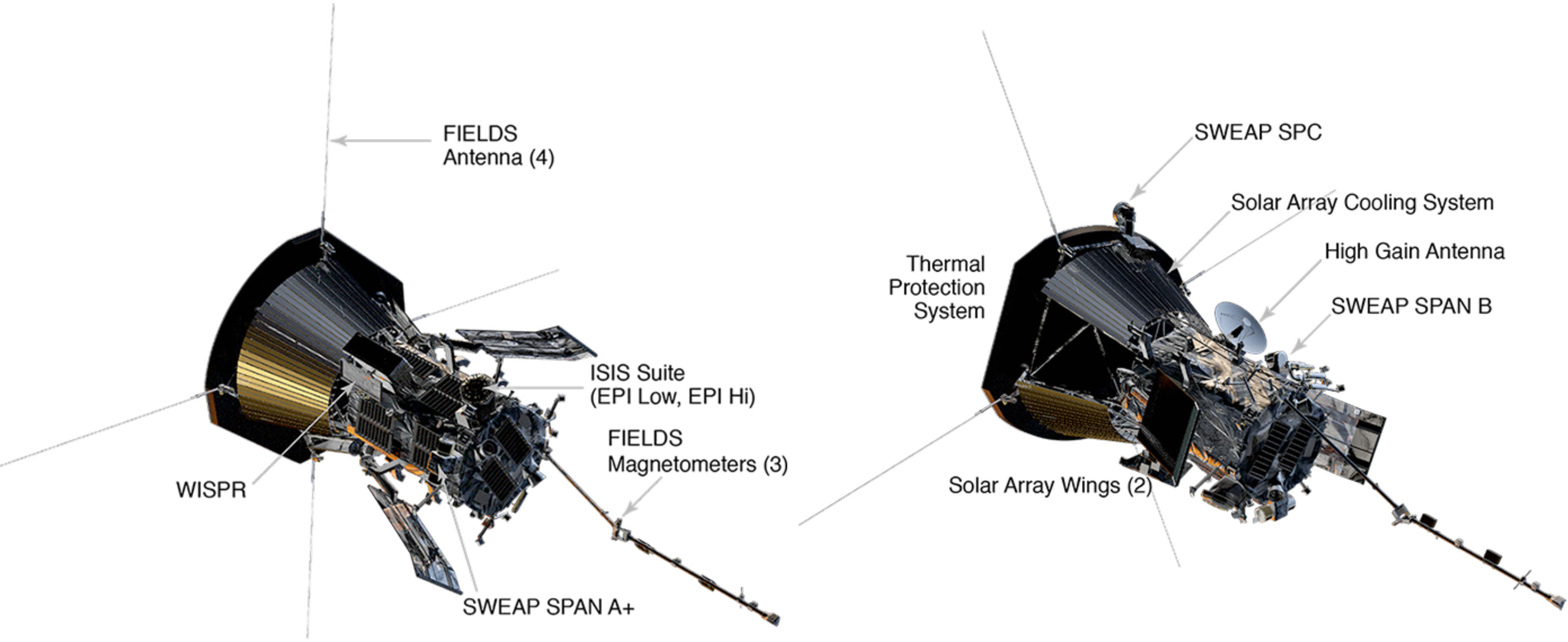
January 2018 Accomplishments

Flight Observatory successfully lifted and installed in the SES Chamber

PSP Payload

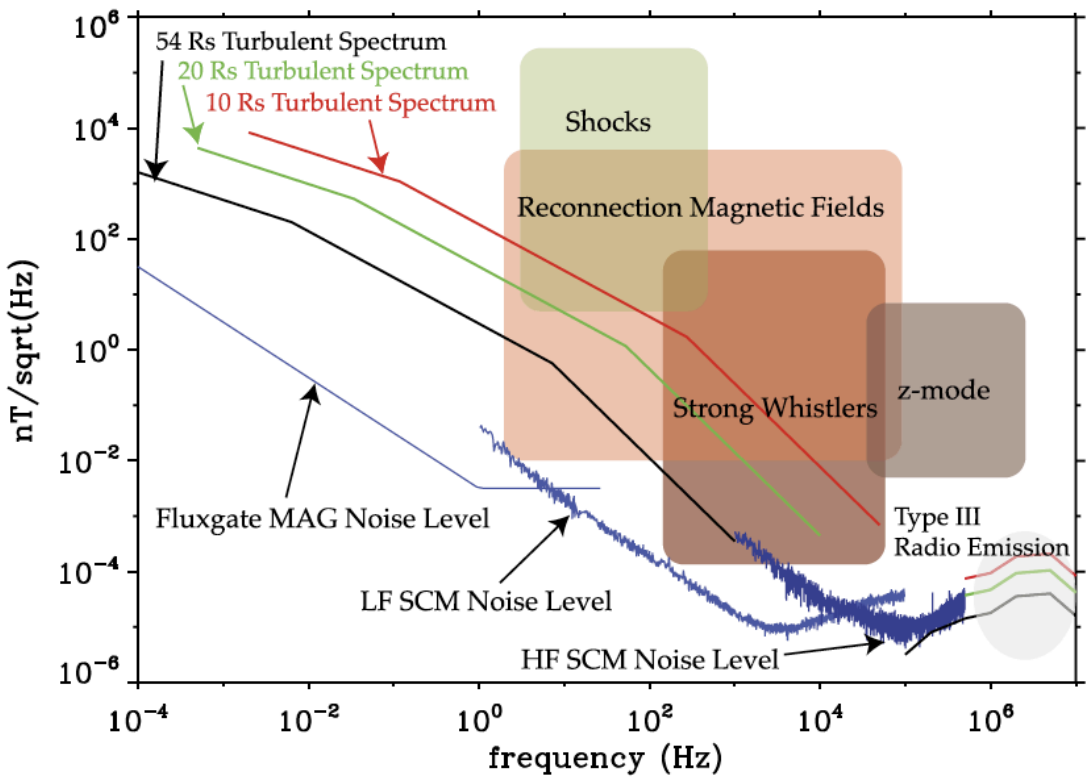
Parker Solar Probe Payload

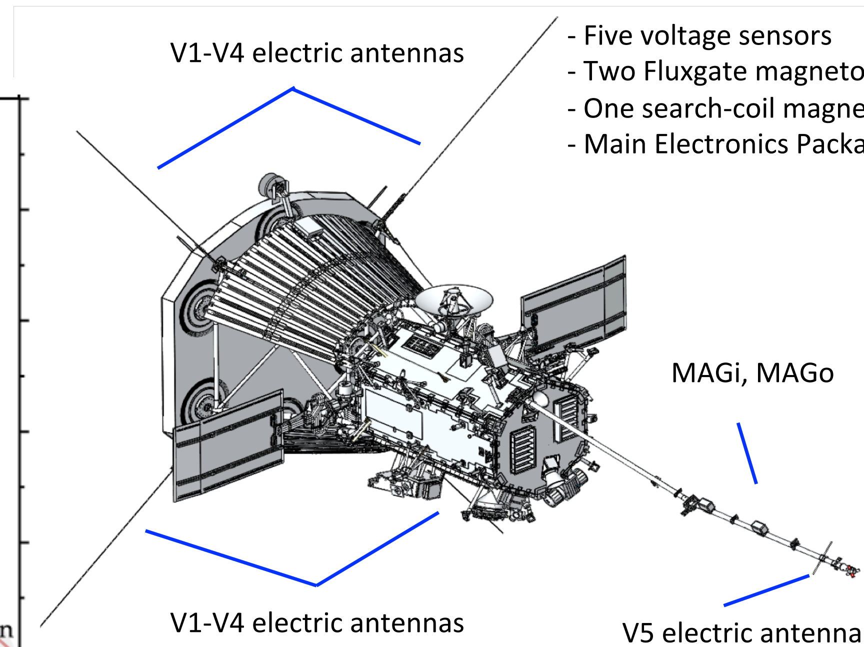


FIELDS

PI: Stuart Bale (Univ. California, Berkeley)

FIELDS will measure electric and magnetic fields and waves, Poynting flux, absolute plasma density and density fluctuations, electron temperature, spacecraft floating potential, and radio emissions.

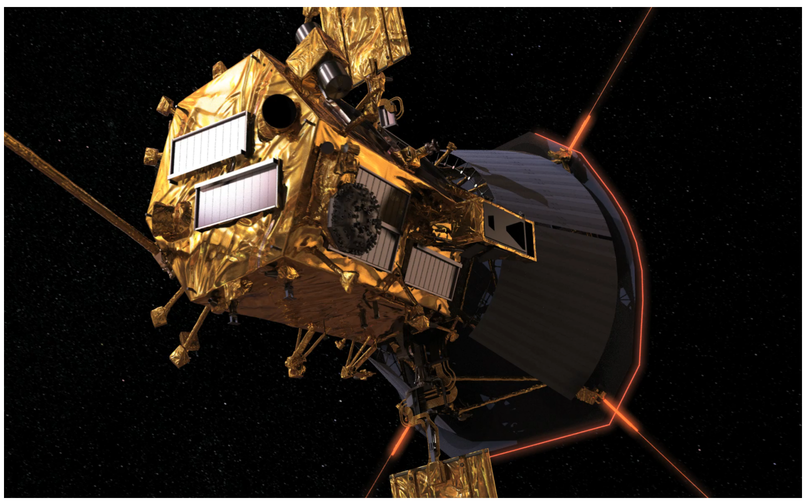


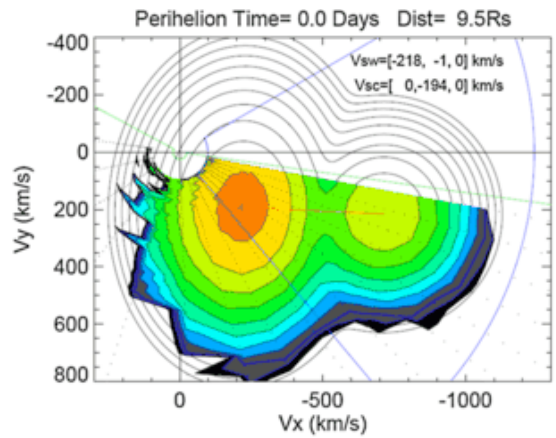


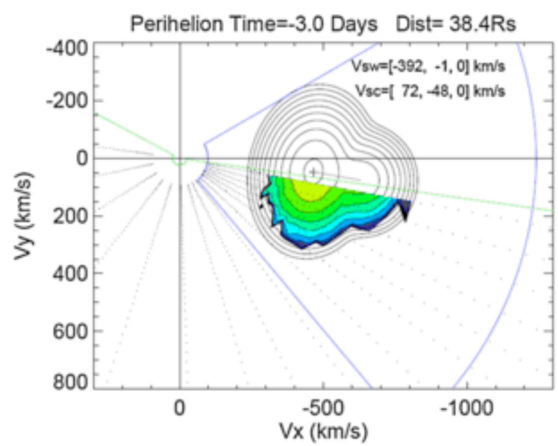
Solar Wind Electron Alphas and Protons (SWEAP)

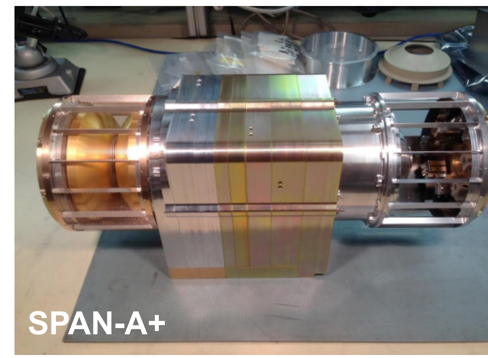
PI: Justin Kasper (Univ. Michigan/SAO)

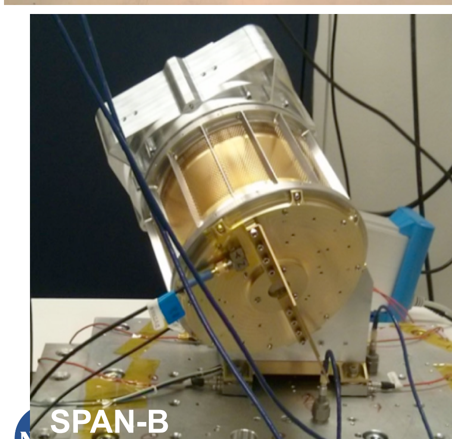
SWEAP will count the most abundant particles in the solar wind -- electrons, protons and helium ions -- and measure their velocity distributions (velocity, density, & temperature).











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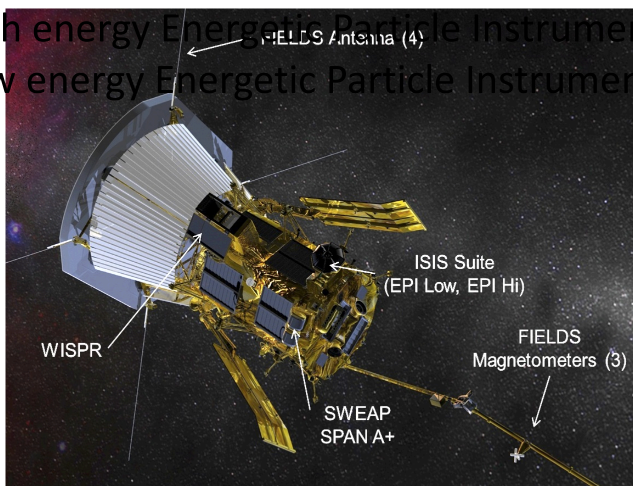
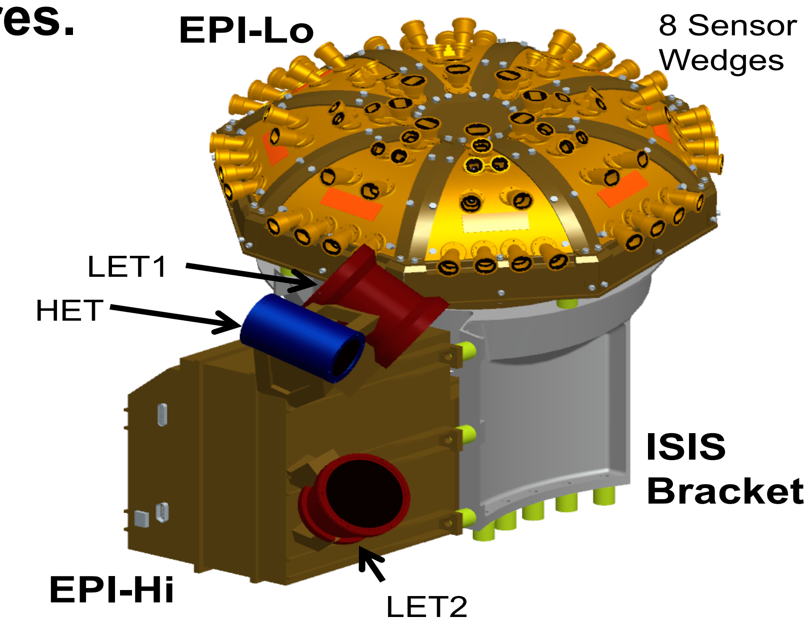
Integrated Science Investigation of the Sun(IS⊙IS)

PI: David McComas (Princeton Univ./SwRI)

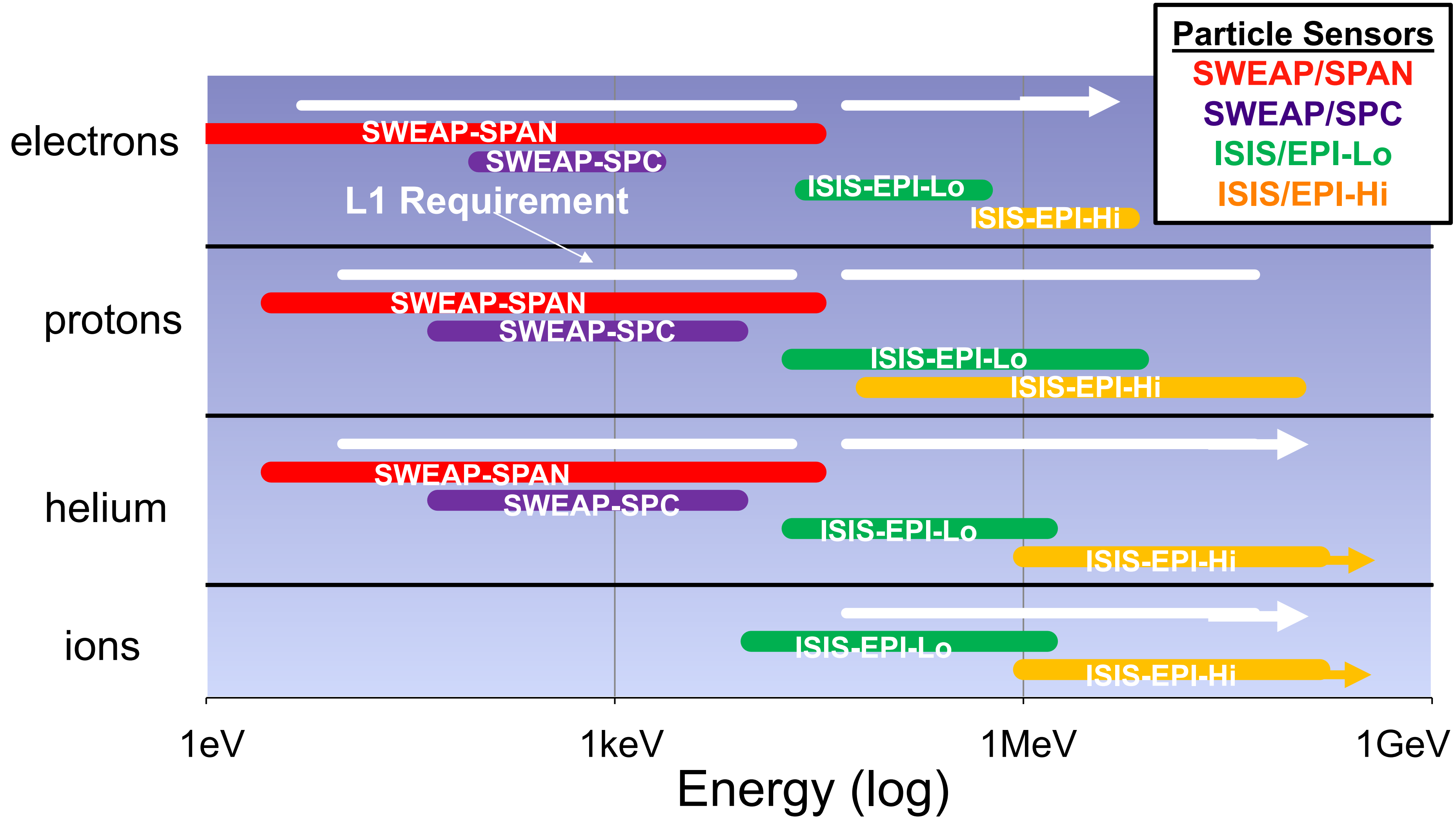
IS⊙IS will measure energetic electrons, protons and heavy ions that are accelerated to high energies (10s of keV to 100 MeV) in the Sun's atmosphere and inner heliosphere, and correlates them with solar wind and coronal structures.

High energy Energetic Particle Instrument (EPI-Hi)
Low energy Energetic Particle Instrument (EPI-Lo)

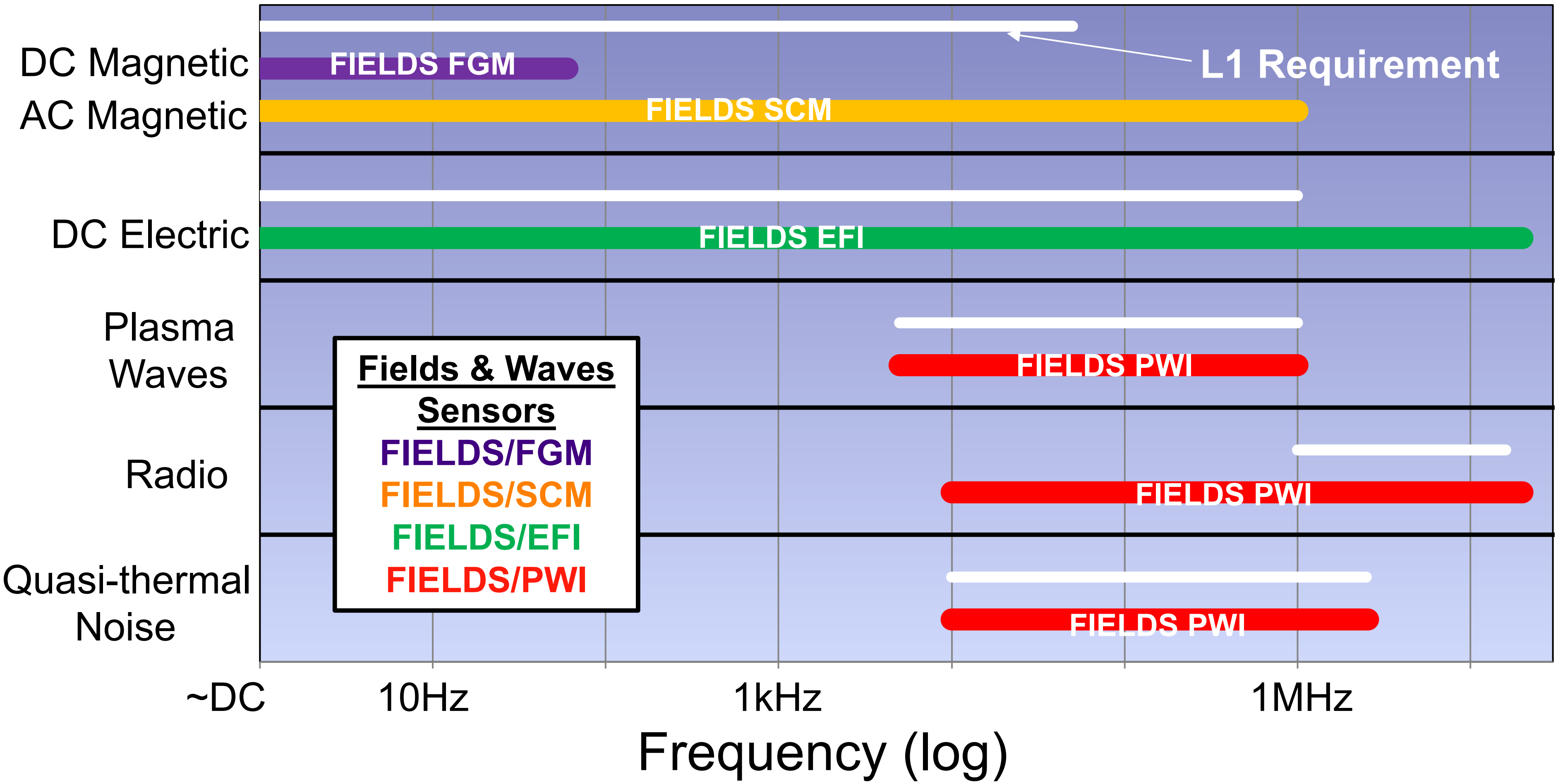




Particle Instrument capabilities meet Level 1 requirements with margin

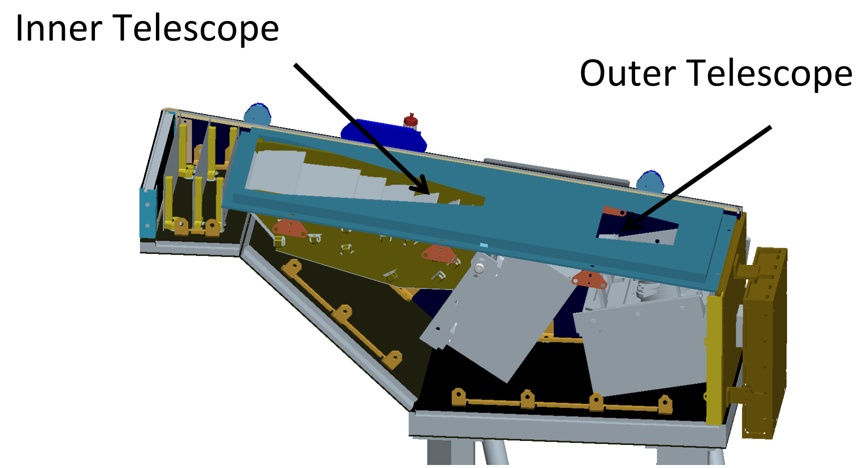


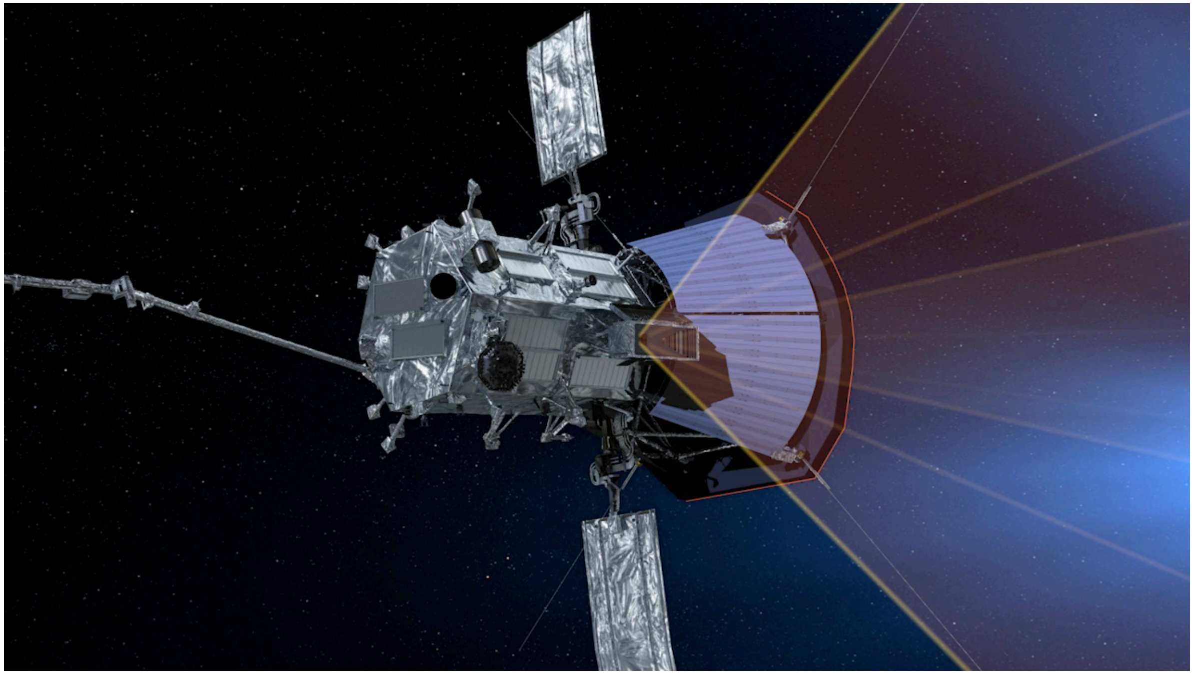
Fields & Waves Instrument capabilities meet Level 1 requirements with margin



Solar Probe Plus Science Investigations (3/4)

WISPR will take images of the solar corona and inner heliosphere. The experiment will also provide images of the solar wind, shocks and other structures as they approach and pass the spacecraft. This investigation complements the other instruments on the spacecraft providing direct measurements by imaging the plasma the other instruments sample.





Orbital Operations Planning Concept

24 Solar Encounter Orbits

Orbital Periods Vary (169 days to 88 days)

Solar Encounter Period

Encounter Phase

- Primary science data collection phase – All instruments can be powered on
- LGA periodically available for communications & Nav
- Real-time commanding supported but not nominally planned

Cruise/Downlink Period

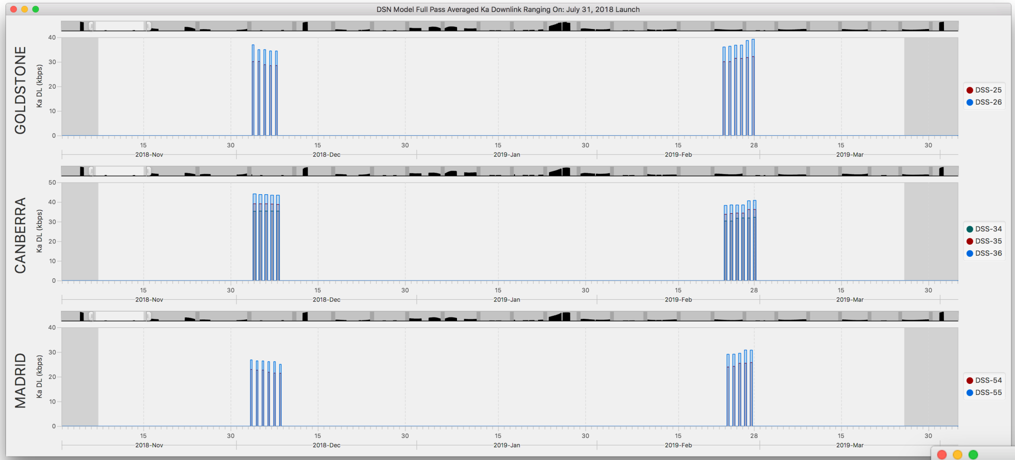
Cruise Phase

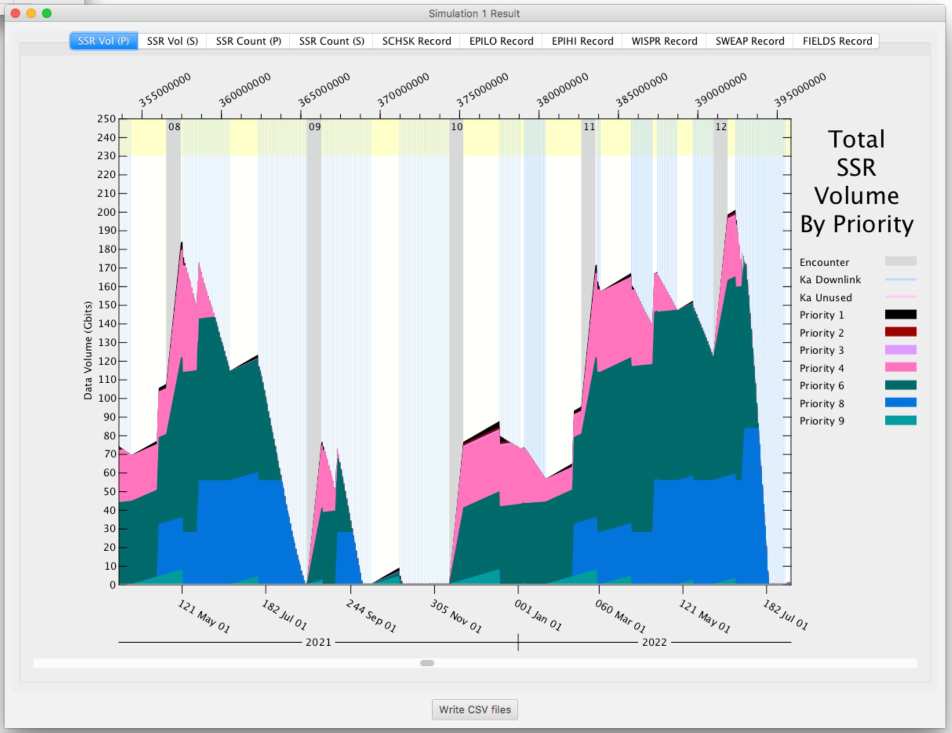
- All instruments nominally powered off
- LGA for communications – H/K data only
- Commanding as needed to support spacecraft maintenance

Science Downlink Phase

- All instruments nominally powered off
- HGA for communications – SSR playbacks
- Commanding as needed to support spacecraft maintenance

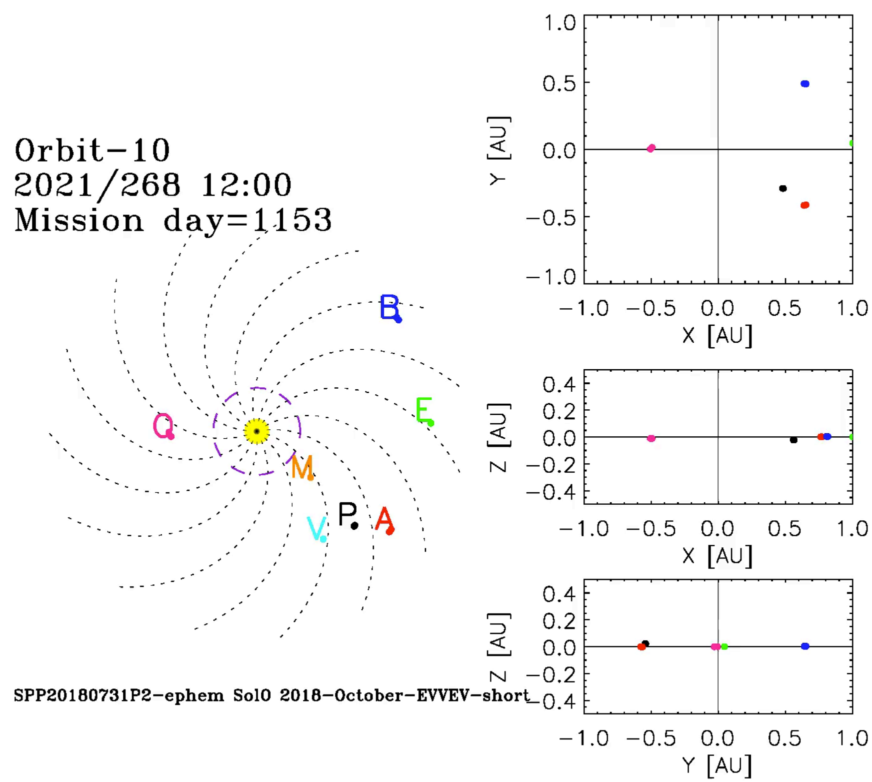
Science Operations

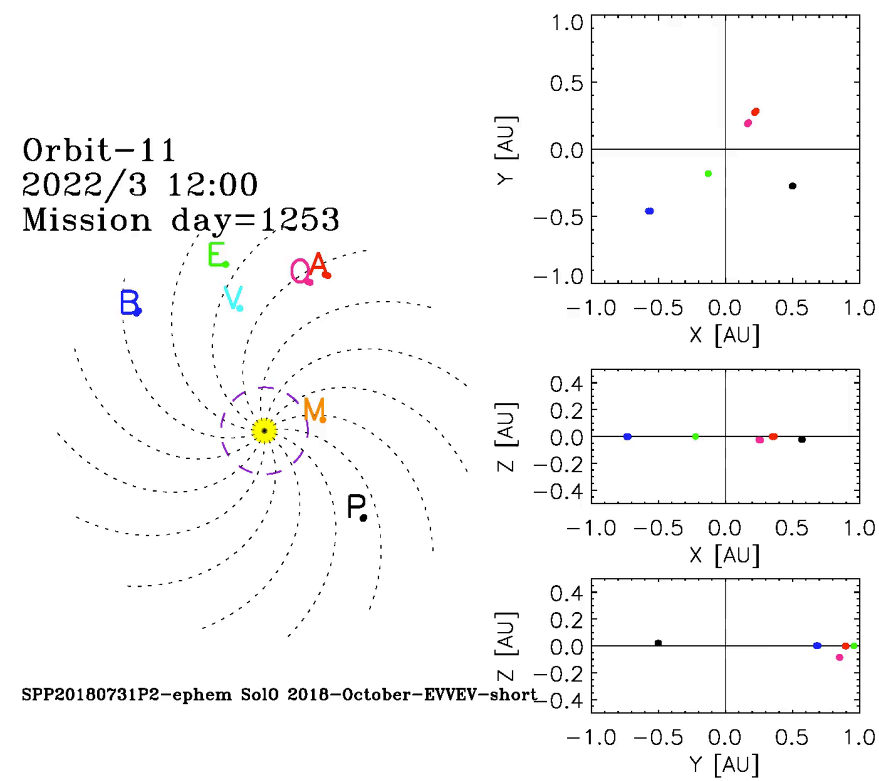




Wanted

PSP-SO-DKIST and all the others





- PSP will DKIST and other observatories to connect heliospheric observations to the solar surface
- Important configuarations: Alignment Co-rotation Quadrature