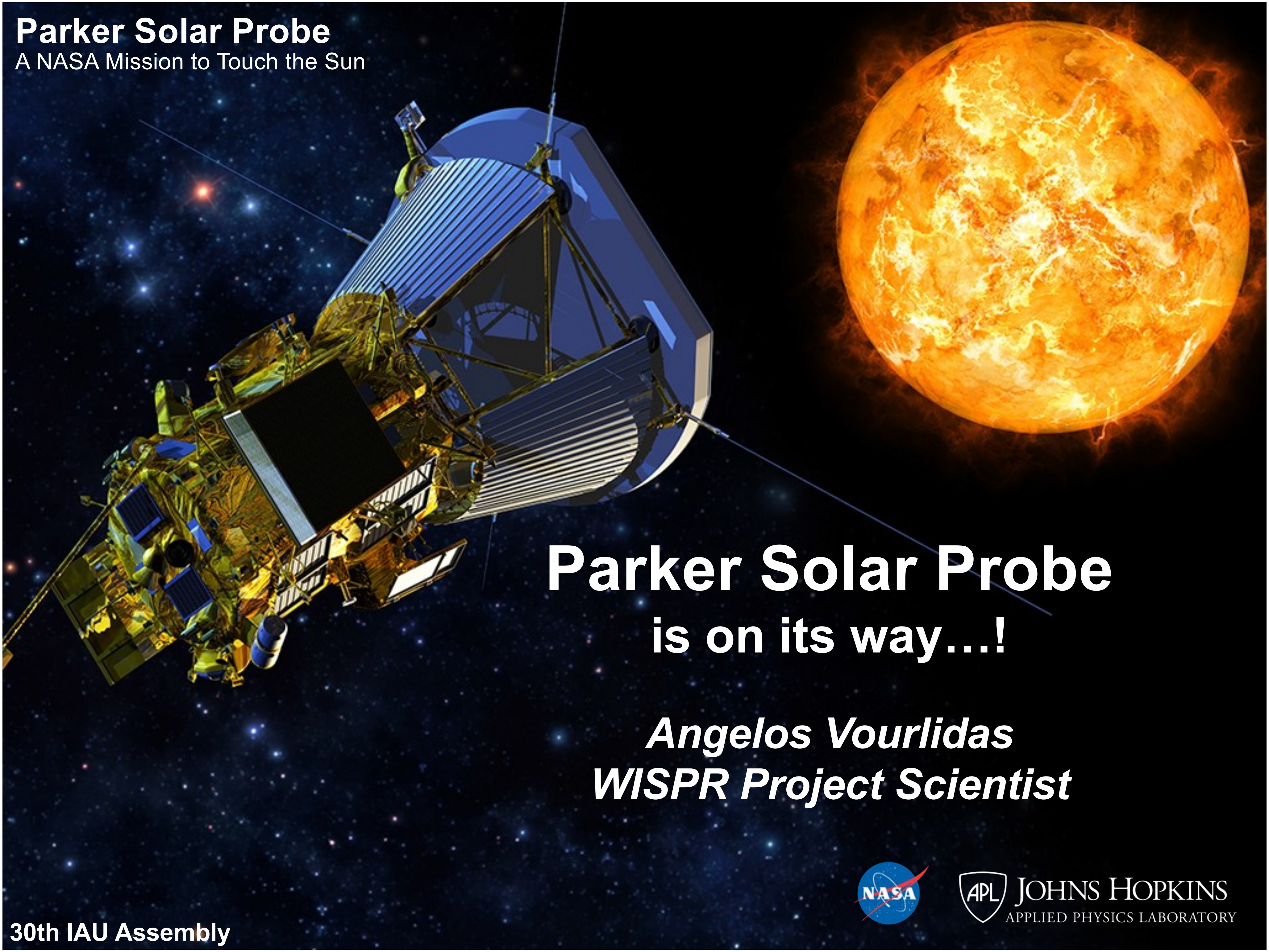
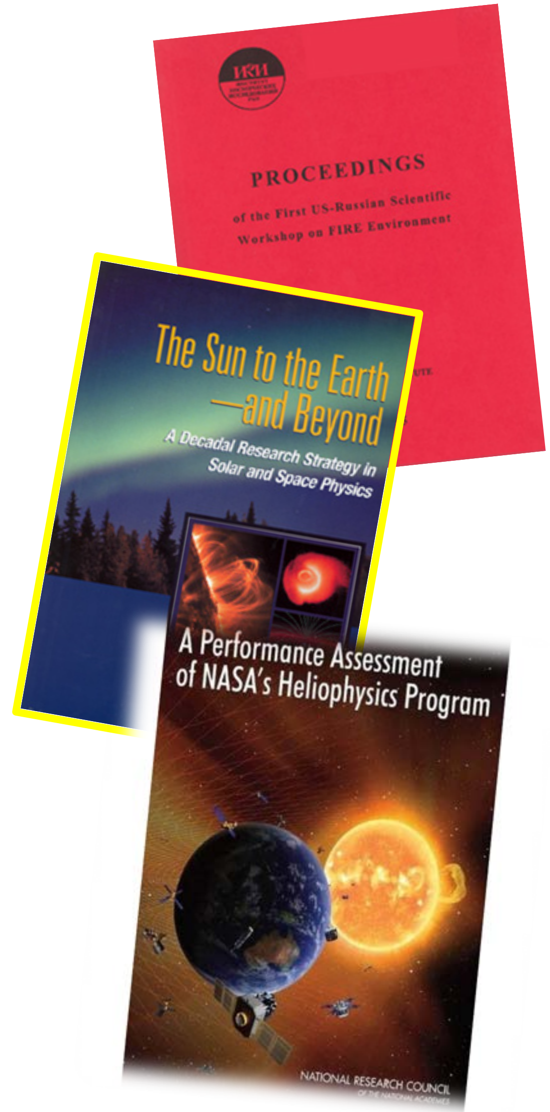

Parker Solar Probe
A NASA Mission to Touch the Sun
Parker Solar Probe
is on its way…!
Angelos Vourlidas
WISPR Project Scientist
NASA
APL JOHNS HOPKINS
APPLIED PHYSICS LABORATORY
30th IAU Assembly

Parker Solar Probe: 60 Years in the Making

- The concept for a "Solar Probe" dates back to "Simpson's Committee" of the Space Science Board (National Academy of Sciences, 24 October 1958)
- This has been of top priority in multiple Roadmaps and Decadal Surveys
- Technological challenges made it possible only now



PSP Mission: Launch and Mission Overview

Launch

- Dates: Aug. 12, 2018
- Max. Launch C3: 154 km^2/s^2
- Delta IV-Heavy w/ Upper Stage

Trajectory Design

- 24 Orbits
- 7 Venus gravity assist flybys

Mission duration:

- 6 years, 11 months

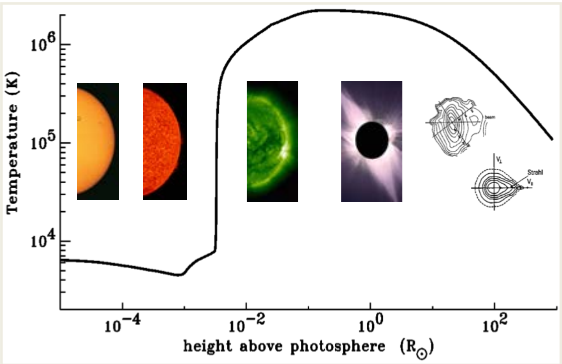
Final Solar Orbits

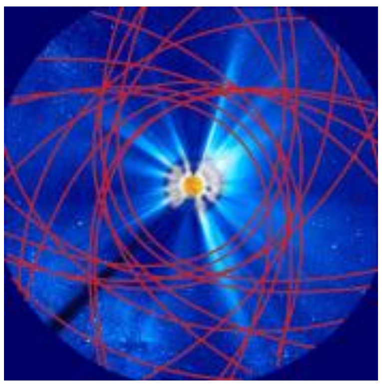
- Closest approach: **9.86 Rs**
- Speed: ~720,000 km/hr **(~200 km/sec)**
- Orbit period: **88 days (sci ops 10 days)**

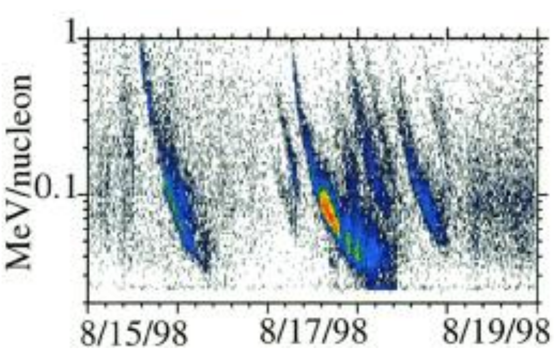
Upcoming Activities

- L30 + 25 days: Commissioning
- Oct 26 – Nov 7 : Encounter #1 (35.7 Rs)
- **Dec 3 – 8: First Science Data Downlink**

PSP Science Objectives





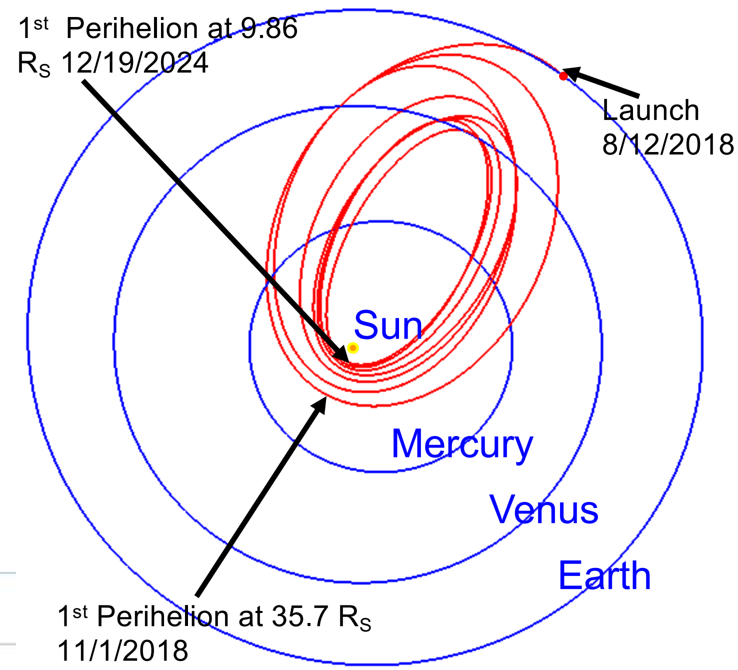


Overarching Science Objective

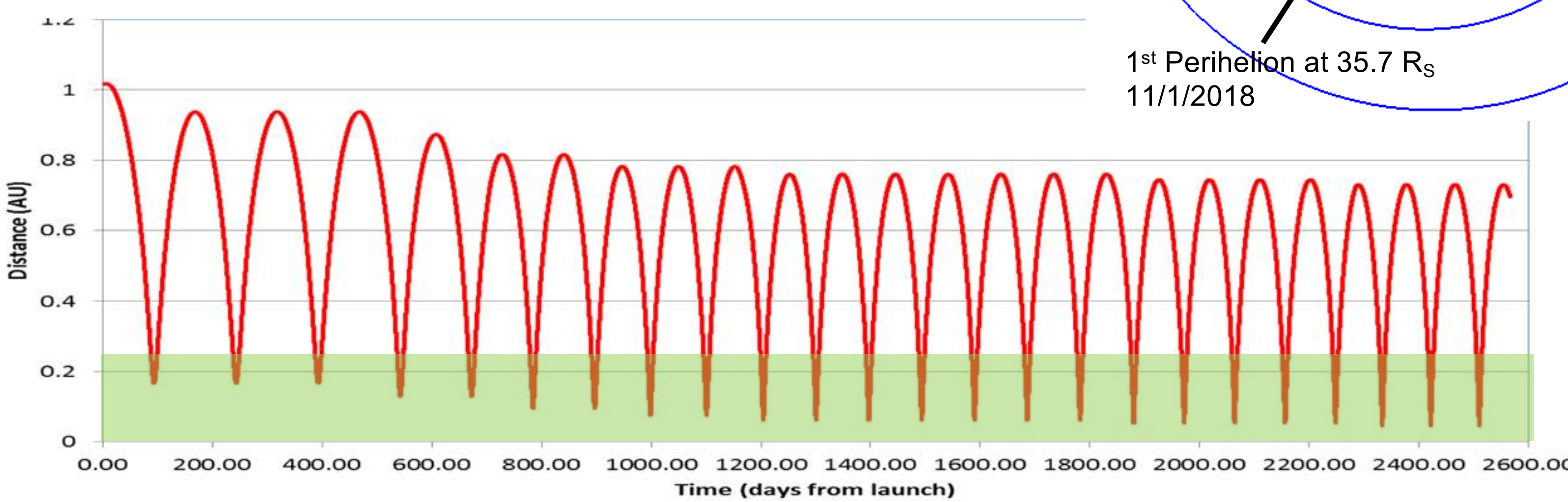
- To determine the structure and dynamics of the Sun's coronal magnetic field, understand how the solar corona and wind are heated and accelerated, and determine what mechanisms accelerate and transport energetic particles.

Detailed Science Objectives

- Trace the flow of energy that heats and accelerates the solar corona and solar wind.
- Determine the structure and dynamics of the plasma and magnetic fields at the sources of the solar wind.
- Explore mechanisms that accelerate and transport energetic particles.



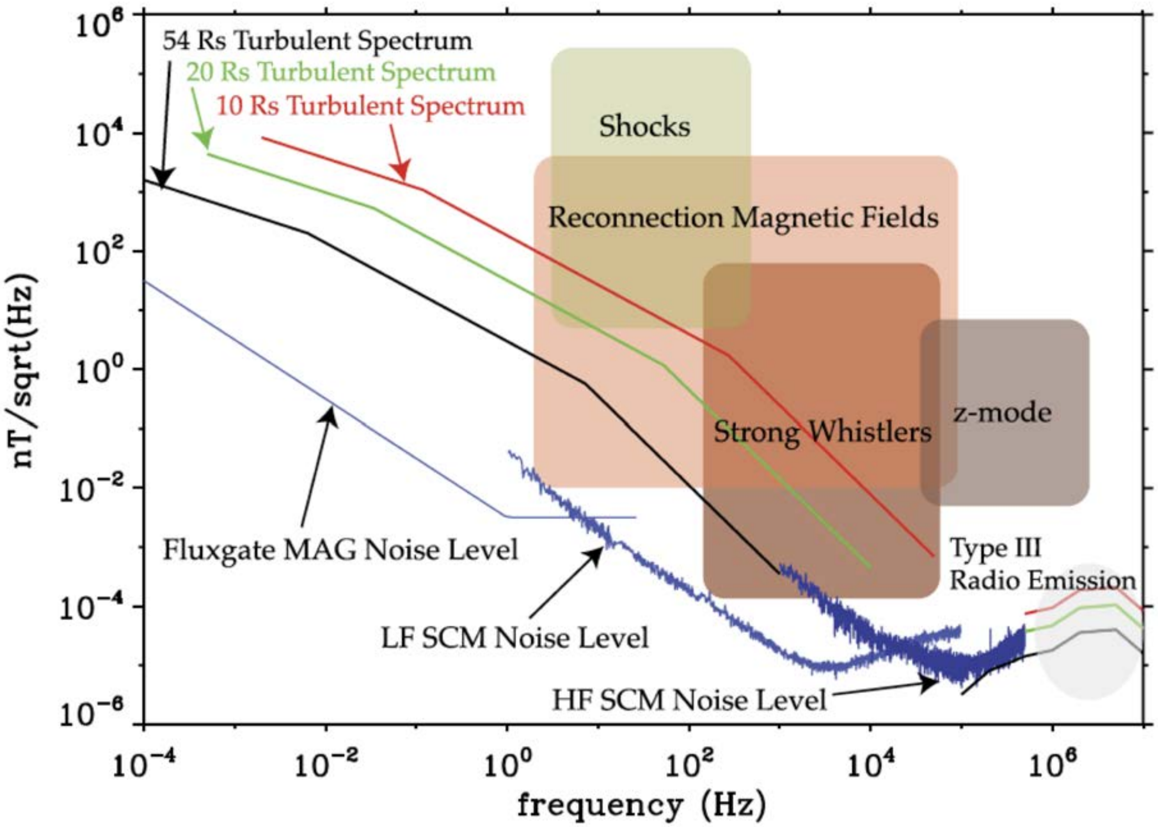
1st Perihelion at 9.86 R_S 12/19/2024
Launch 8/12/2018
Sun
Mercury
Venus
Earth
1st Perihelion at 35.7 R_S 11/1/2018

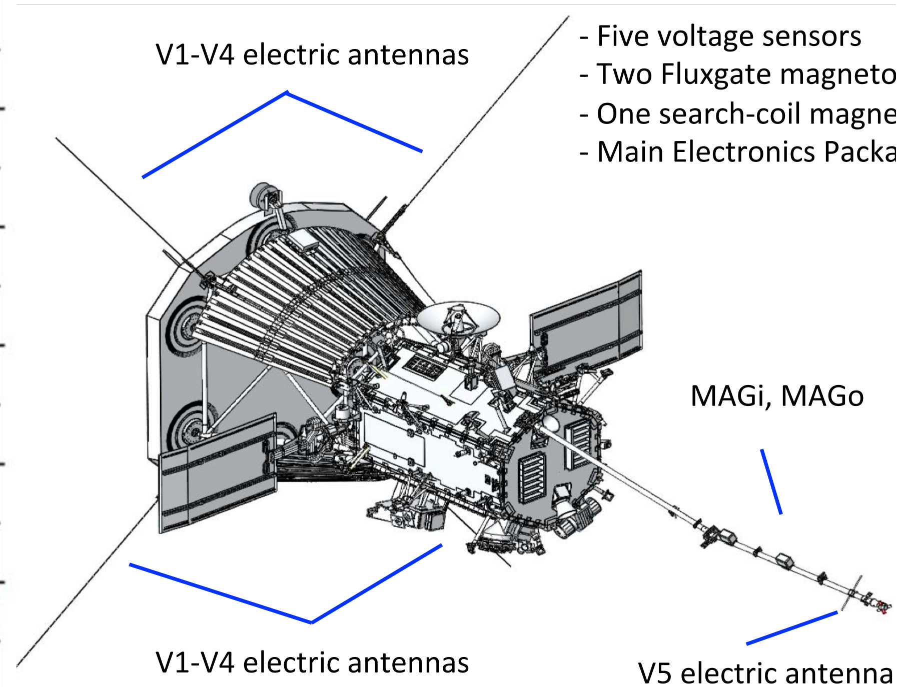


Distance (AU)
1
0.8
0.6
0.4
0.2
0
0.00
200.00
400.00
600.00
800.00
1000.00
1200.00
1400.00
1600.00
1800.00
2000.00
2200.00
2400.00
2600.00
Time (days from launch)

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.

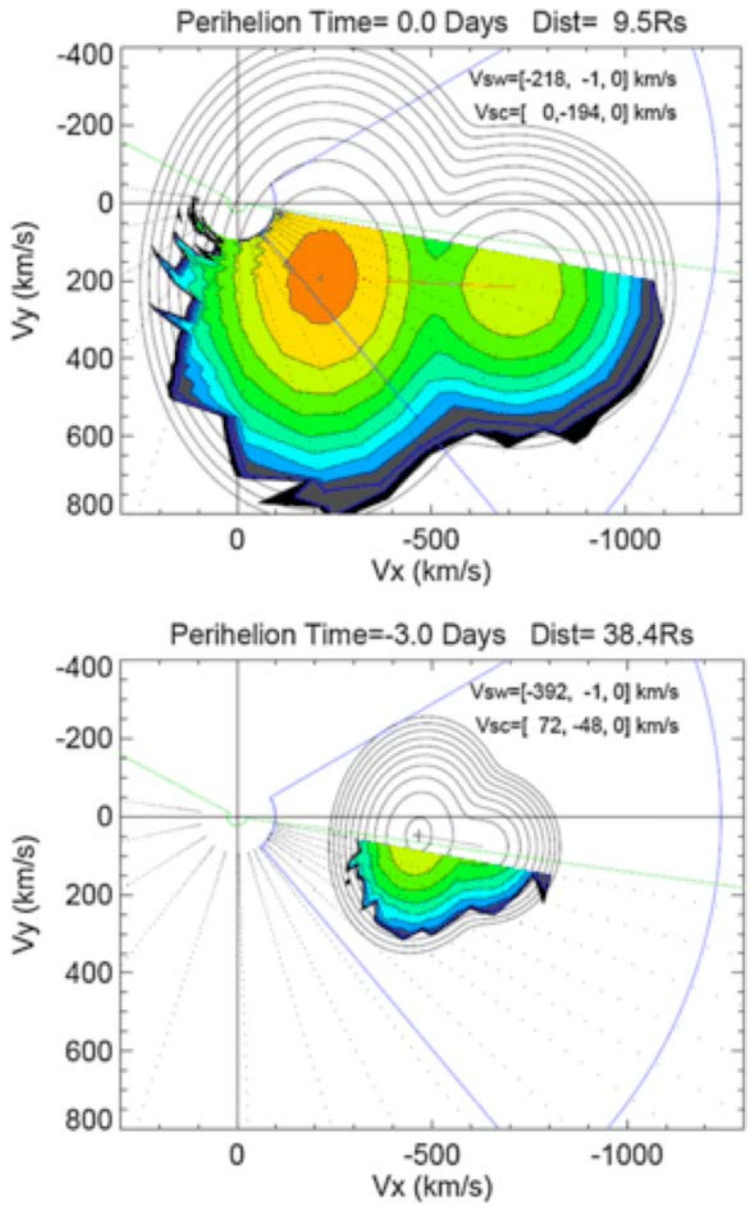


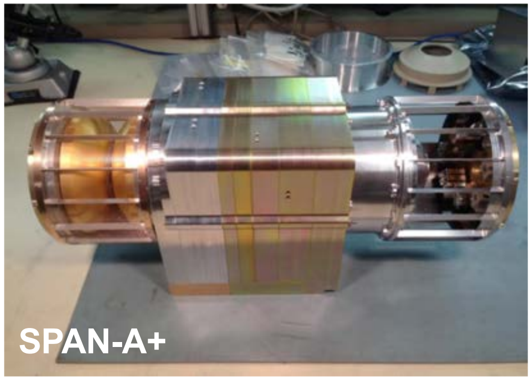


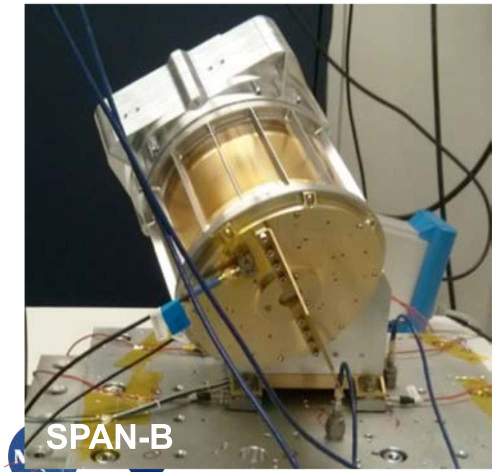
Bale, S. D., et al., “The FIELDS Instrument Suite for Solar Probe Plus … ,” Space Science Reviews, 204, 49, 2016

Solar Wind Electron Alphas & 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).



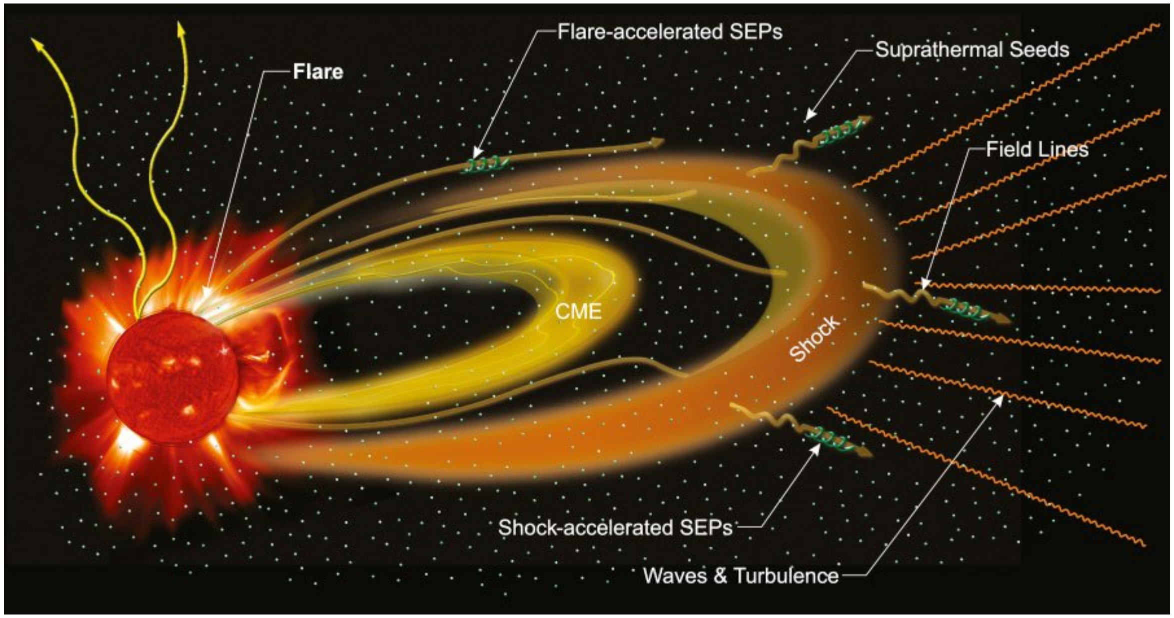


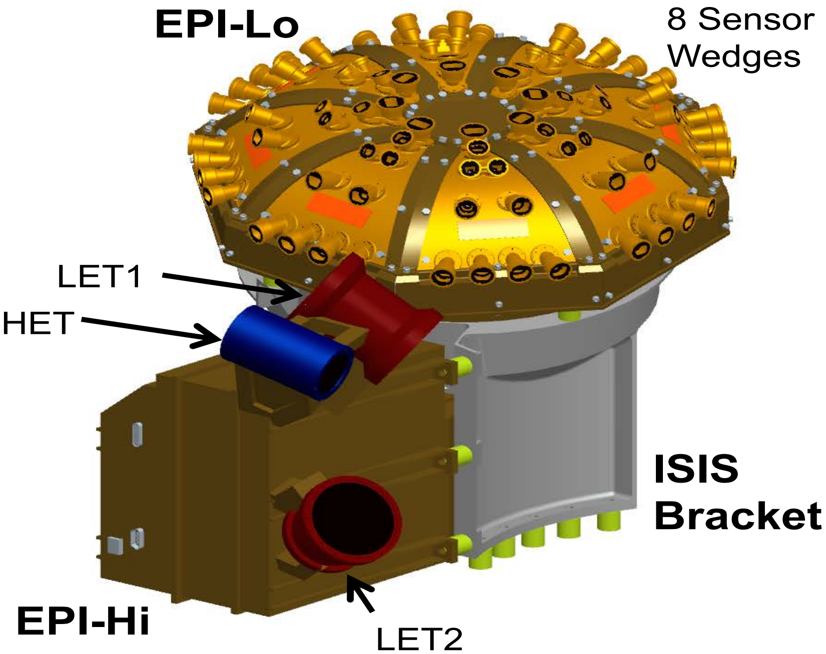


Kasper, J. C., et al., “Solar Wind Electrons Alphas and Protons (SWEAP) Investigation …,” Space Science Reviews, 204, 131, 2016

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.

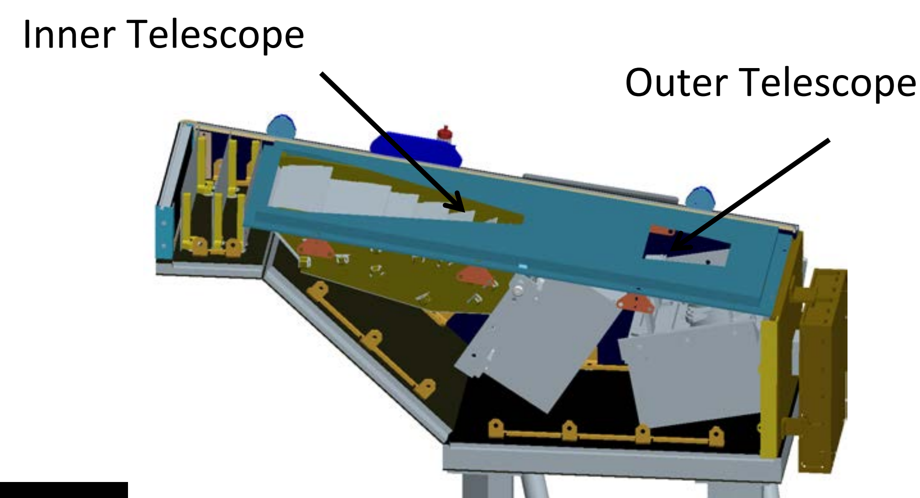


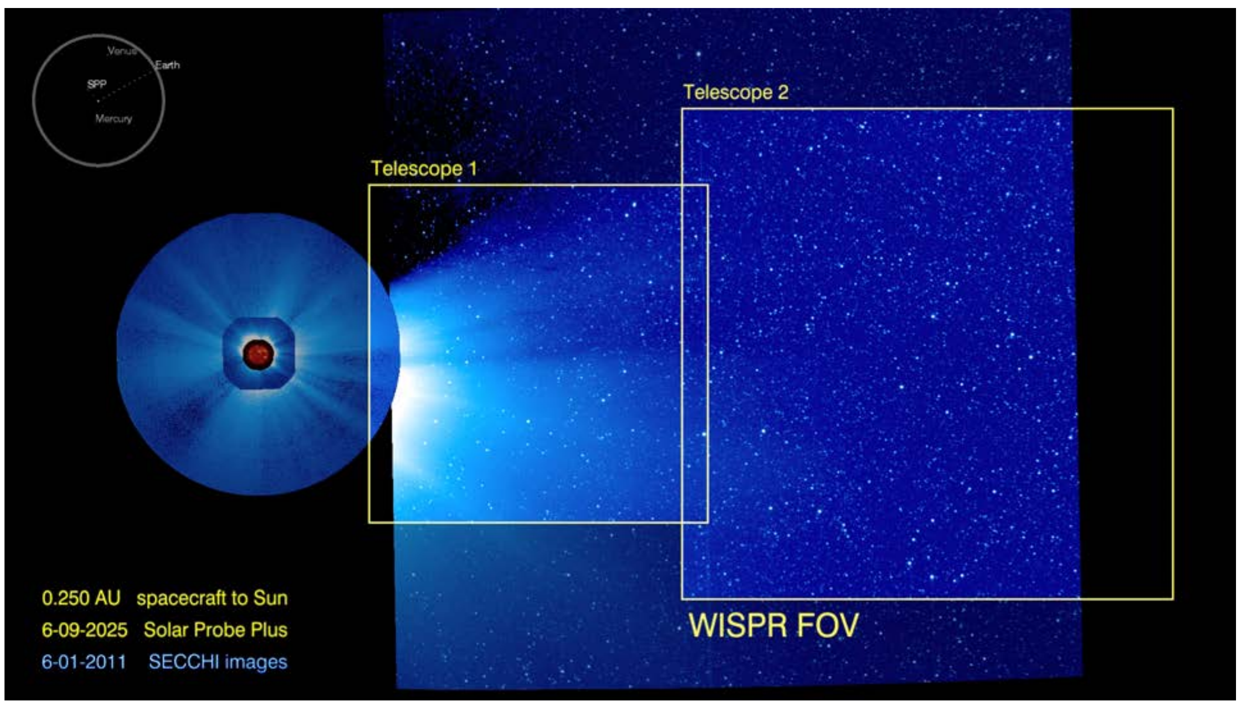


McComas, D. J., et al., "Integrated Science Investigation of the Sun (IS⊙IS): Design of the Energetic Particle Investigation," Space Science Reviews, 204, 187, 2016

Wide-Field Imager for Solar Probe Plus (WISPR)
PI: Russ Howard (NRL)

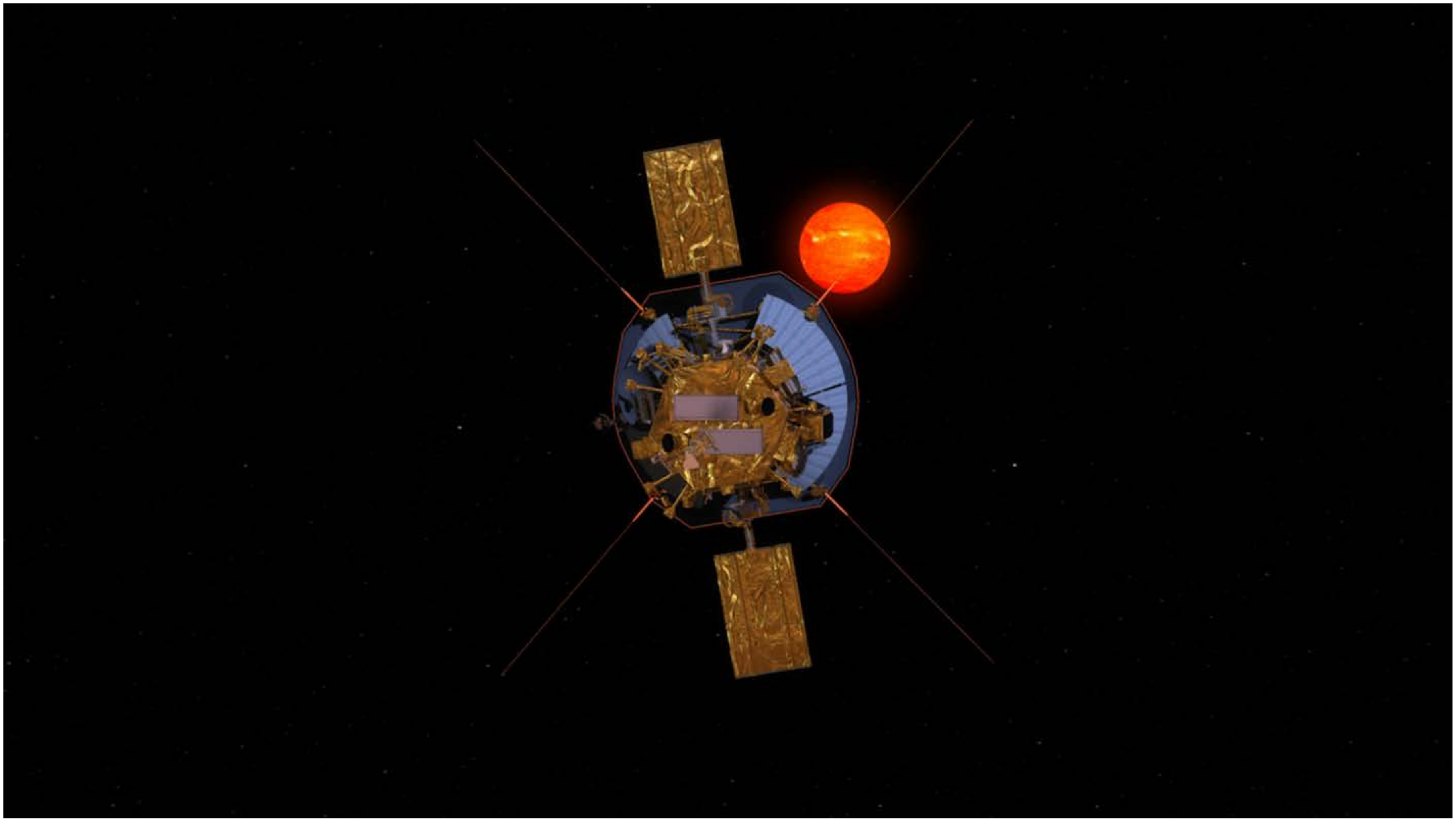
WISPR will image of the solar wind, shocks and other structures as they approach and pass the spacecraft. This investigation complements the other instruments on the spacecraft providing direct measurements by imaging the plasma the other instruments sample.



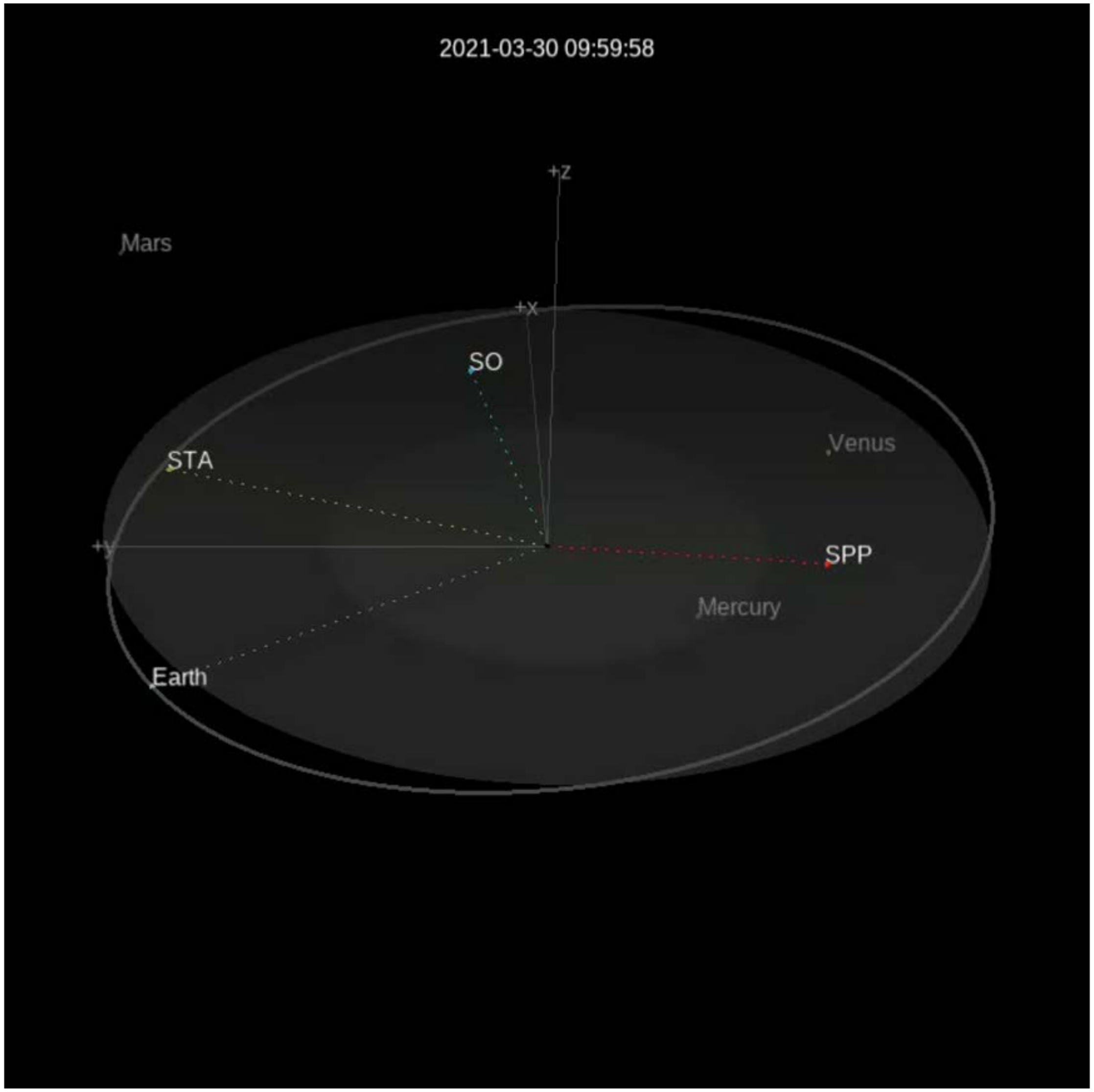


Vourlidas, A., et al., "The Wide-Field Imager for Solar Probe Plus (**WISPR**)," Space Science Reviews, 204, 83, 2016

PSP corotation periods are key to untangling connection to corona



Inner Heliosphere Network (2021+)



Solar Orbiter, PSP, STEREO-A & Earth orbits in 2021-2023

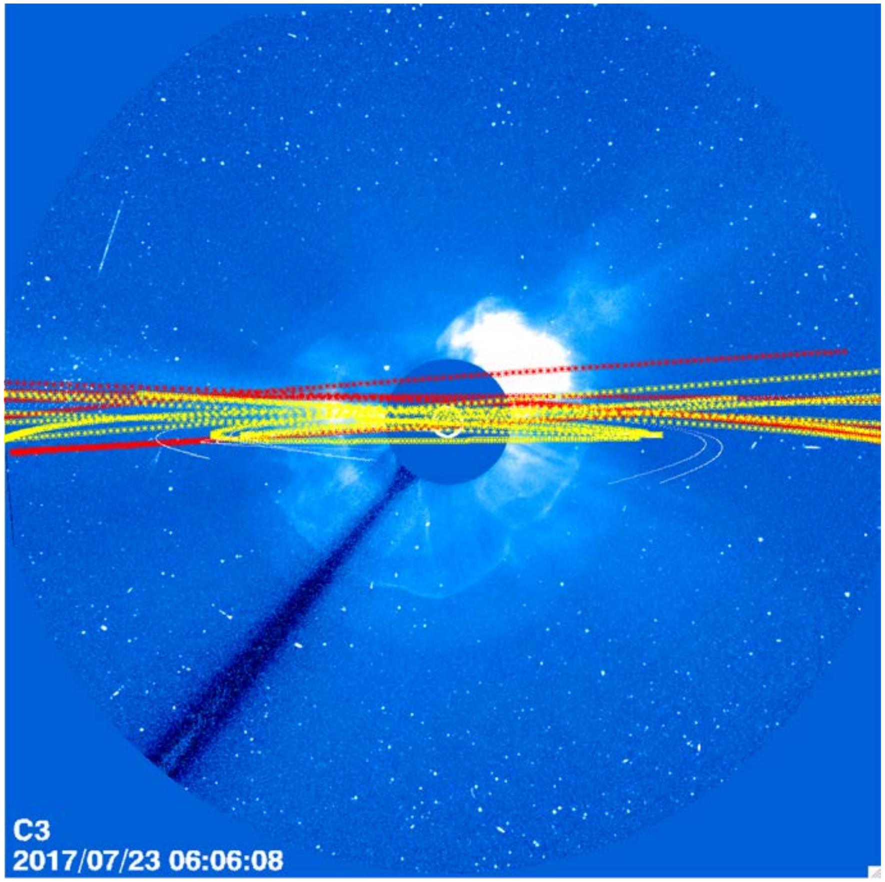
PSP/SO are **VERY Different** than Current Solar Missions:

- **Encounter**
- **Long Latency**
- **Variable Viewpoints**
- **Emphasis on in-situ meas.**

- **PSP Corotation (~2 days/orbit)**
- **SO Near-Corotation**

Synergies with Ground- & L1-Based Observatories

PSP in C3 FOV



The Role of Ground-Based Network

- **Monitoring**
  - 24/7 observations of solar conditions (transient activity, coronal hole evolution, etc.)
- **Forecasting**
  - Using the monitoring data to create forecast of the conditions on the Sun and inner heliosphere.
- **Modeling**
  - Useful for certain kinds of modeling. Will play a central role in realizing the PSP-GBN objectives.
- **Mission Planning**
  - GBN can provide 'situational awareness' for solar/heliospheric conditions that would be useful for the PSP science operations.

PSP-GBN White Paper
https://sppgway.jhuapl.edu/sites/default/files/Pubs/SPP-GBN-WhitePaper-v5.0.pdf

RECAP

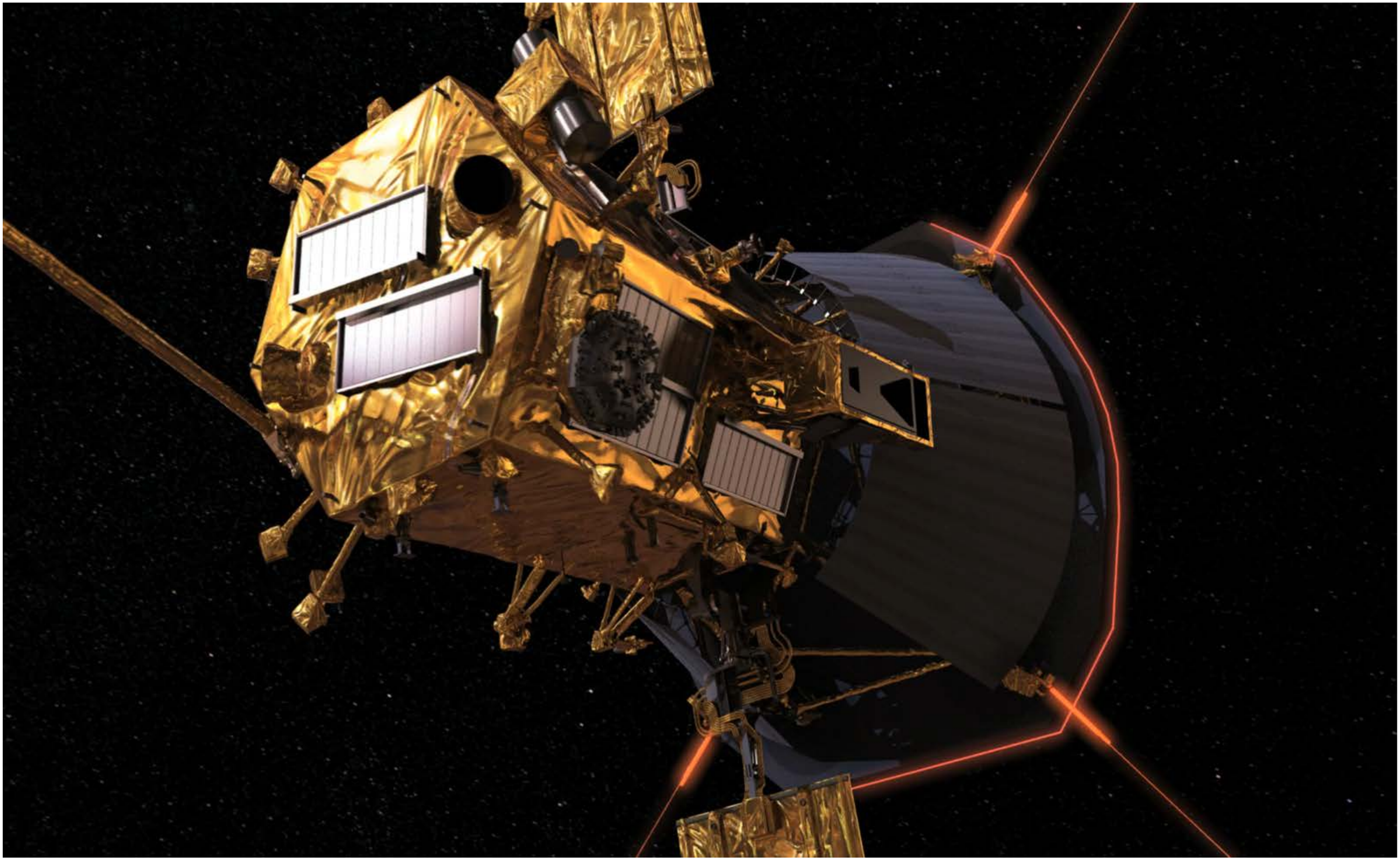
- PSP is a very different mission than past solar physics missions
  - Observations: Encounter not synoptic
  - Data: Long latency not real time
  - Methodology: in-situ measurements not imaging
  - Viewpoint: actively changing not constant

- Emphasis on quiescent structures, kinetic scales, 3D structure
  - CMEs, shocks and SEPs may be few but extremely valuable

- Strong synergies with off-limb observations (e.g. coronagraphs, off-limb spectrometers, etc.)

- synergies with disk/low atmosphere measurements (e.g., disk imagers and spectrometers, magnetographs, etc.)

The Parker Solar Probe
A Mission of Extremes



JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

Parker Solar Probe: Resources

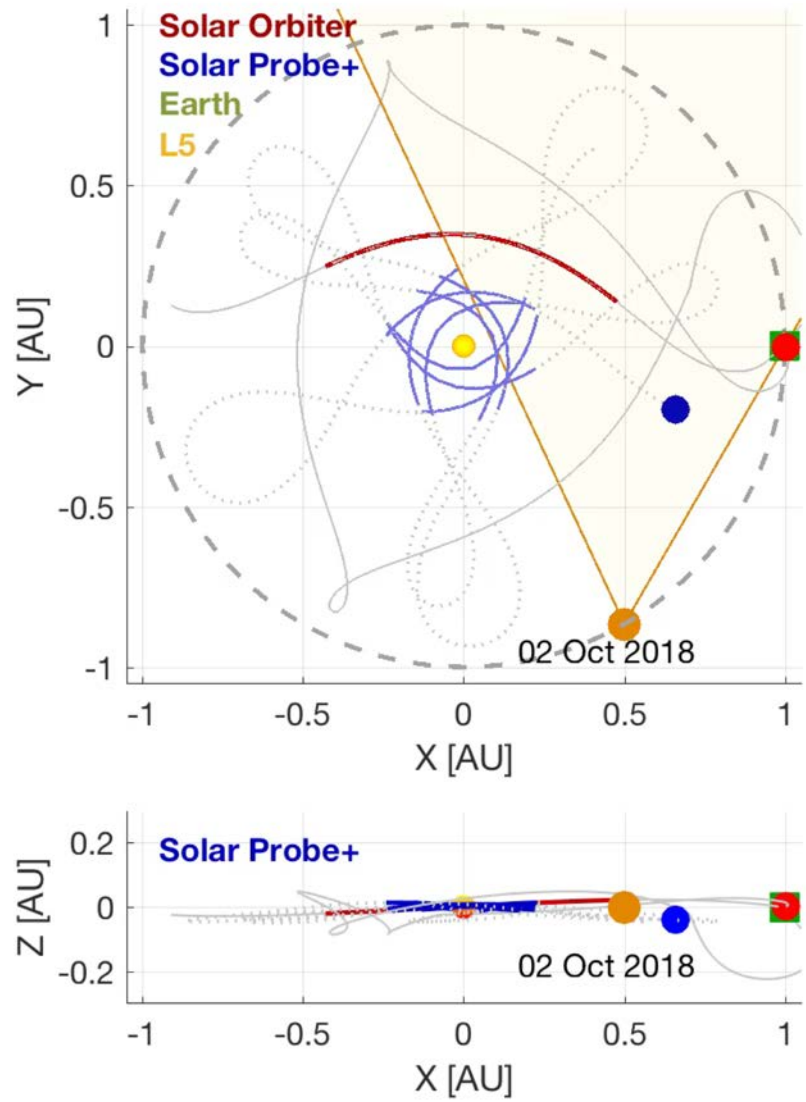
All Open Access

- Fox, N. J., et al., "The **Solar Probe Plus Mission**: Humanity's First Visit to Our Star," Space Science Reviews, 204, 7, 2016
- Bale, S. D., et al., "The **FIELDS** Instrument Suite for Solar Probe Plus. Measuring the Coronal Plasma and Magnetic Field, Plasma Waves and Turbulence, and Radio Signatures of Solar Transients," Space Science Reviews, 204, 49, 2016
- Vourlidas, A., et al., "The Wide-Field Imager for Solar Probe Plus (**WISPR**)," Space Science Reviews, 204, 83, 2016
- Kasper, J. C., et al., "Solar Wind Electrons Alphas and Protons (**SWEAP**) Investigation: Design of the Solar Wind and Coronal Plasma Instrument Suite for Solar Probe Plus," Space Science Reviews, 204, 131, 2016
- McComas, D. J., et al., "Integrated Science Investigation of the Sun (**ISʘIS**): Design of the Energetic Particle Investigation," Space Science Reviews, 204, 187, 2016

In preparation: new series of papers about instrument calibration, upgrades, operation, etc.

Visualizing the PSP and SO Orbits

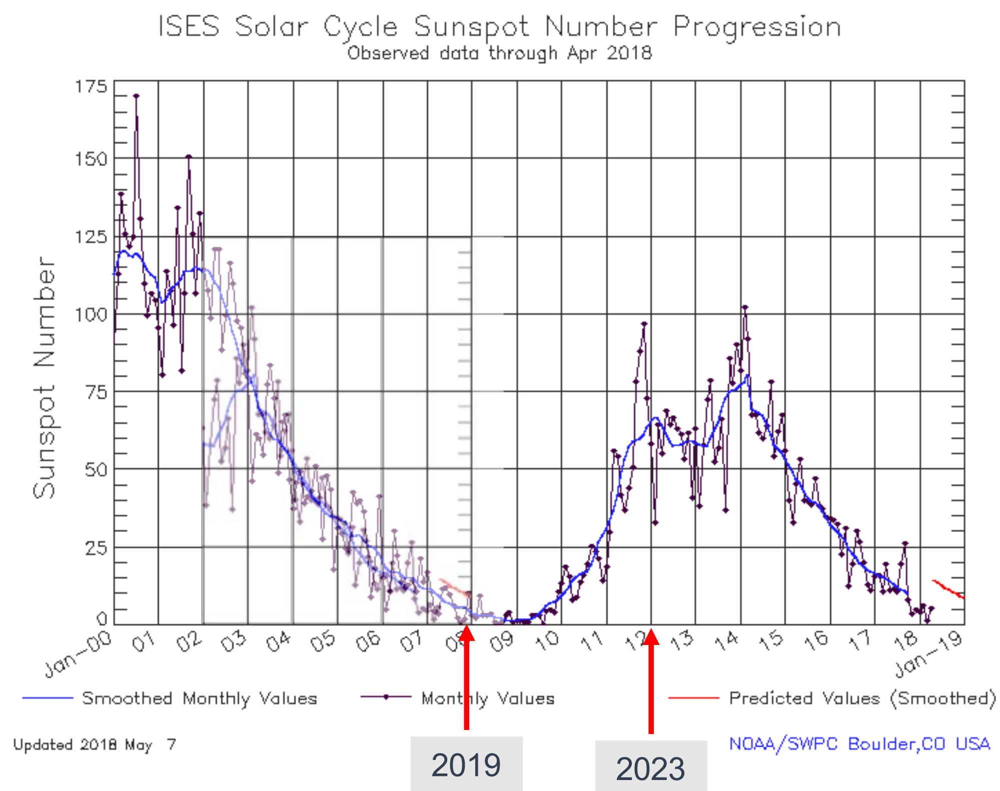
- Necessary for science planning
- Tools available:
  - IDL routines (sorbet.pro, vizzer.pro). Contact: A. Vourlidas
  - YouTube playlist of PSP/SP movies by N. Savani: https://www.youtube.com/watch?v=oaCgWEbN1vk&list=PLZo7abHVYqFc03NeSOv6tcK5014Ree0Q-



CME Rate Estimates

Estimate of CME occurrence rates during prime phase (4/2021 - 9/2025):

- Minimum ~on 01/2019; current slope is sharper than C23 slope.
- Therefore, 2021-23 is rise to max.
  Maximum ~ 2023-2025.



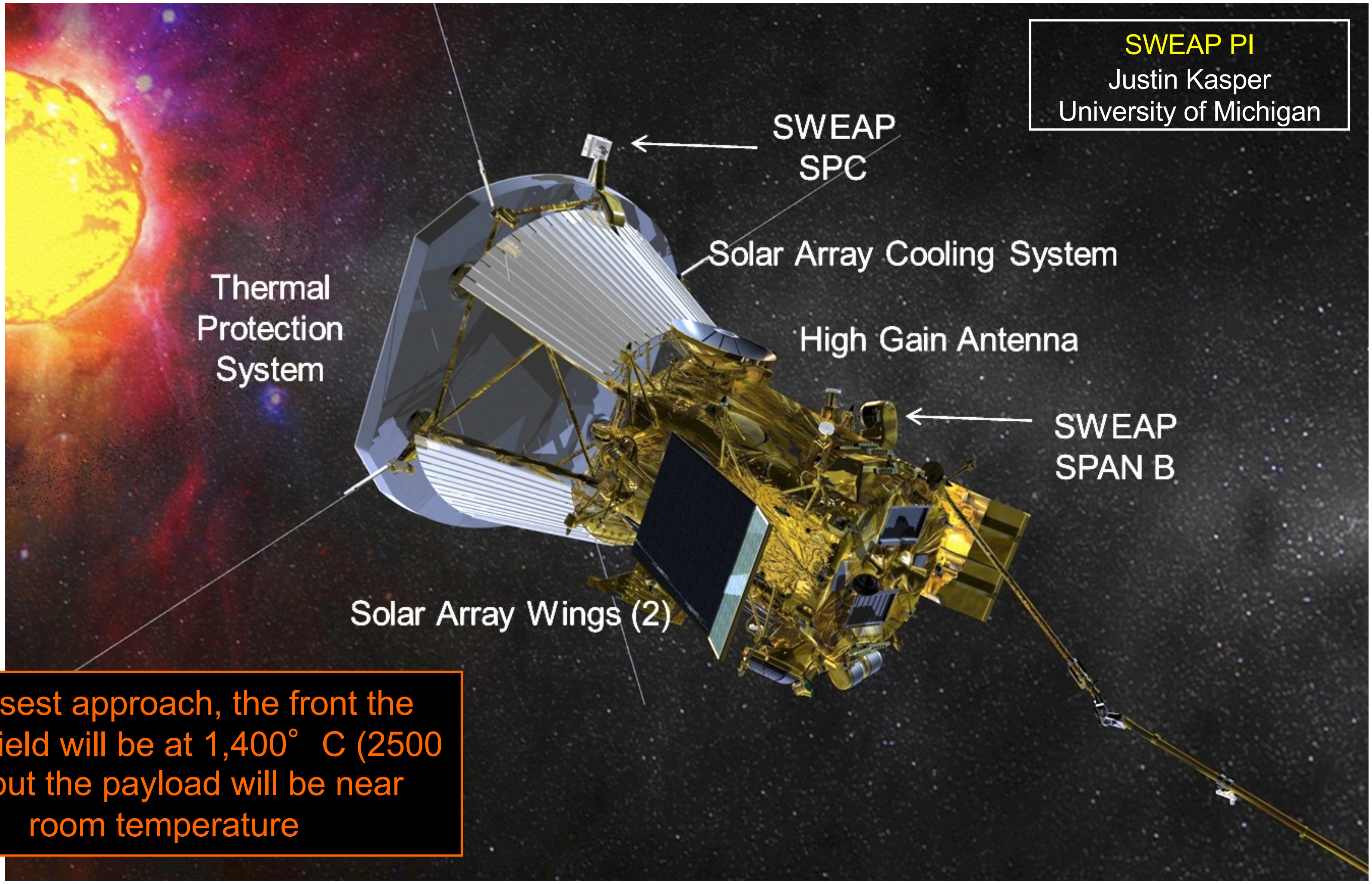
Using 2010-14 as guide…

- **119 CMEs** >1000 Km/s, >20 deg width.
- SoloHI nominal Duty Cycle **(~18%**, 30/165). SoloHI FOV: Coverage 40/360 (~11%)*.

- Expect to see at least **2-3 CMEs** w/ potential shock signs.
- *Expect to cross ~**20 CMEs < 0.4 AU** for in-situ measurements (assuming 2007-2017 stats)*

** WISPR duty cycle (12.5% 11/88 days)*

PSP Vehicle: Anti-Ram Facing View



At closest approach, the front the heat shield will be at 1,400° C (2500 °F), but the payload will be near room temperature

PSP Vehicle: Ram-Facing View