Science Collaboration Opportunities with Parker Solar Probe

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Outline

- Science Goals and Instrumentation
- Data Availability/Release Requirements
- Science Coordination Opportunities

Parker Solar Probe Science

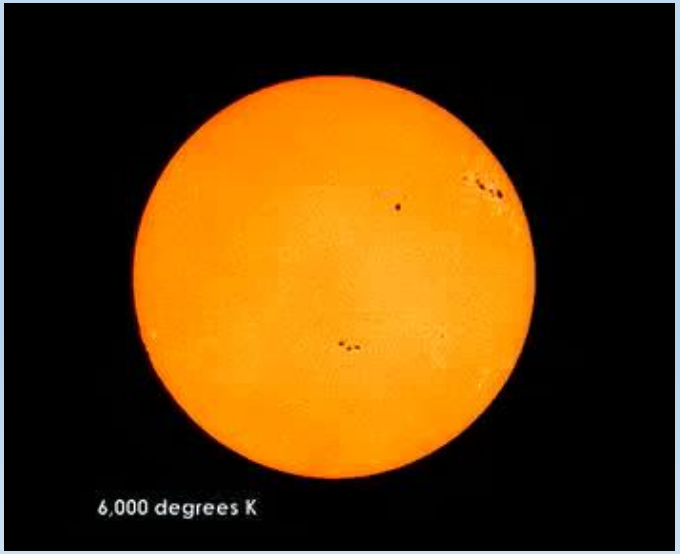
The Parker Solar Probe Mission is the first space mission to probe the innermost heliosphere, the *closest accessible region* to where

- ***the corona is heated***
- ***the solar wind originates***
- ***high-energy solar energetic particles are accelerated***

It is the first spacecraft to have reached co-rotation with the Sun.

Science Goals

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.

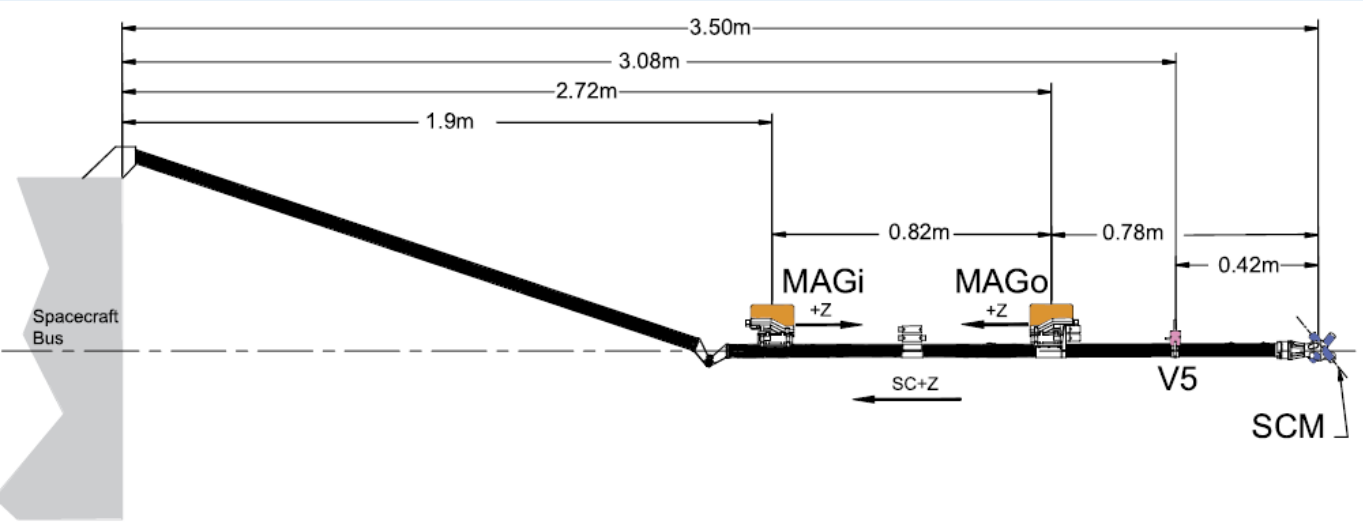


Instrumentation

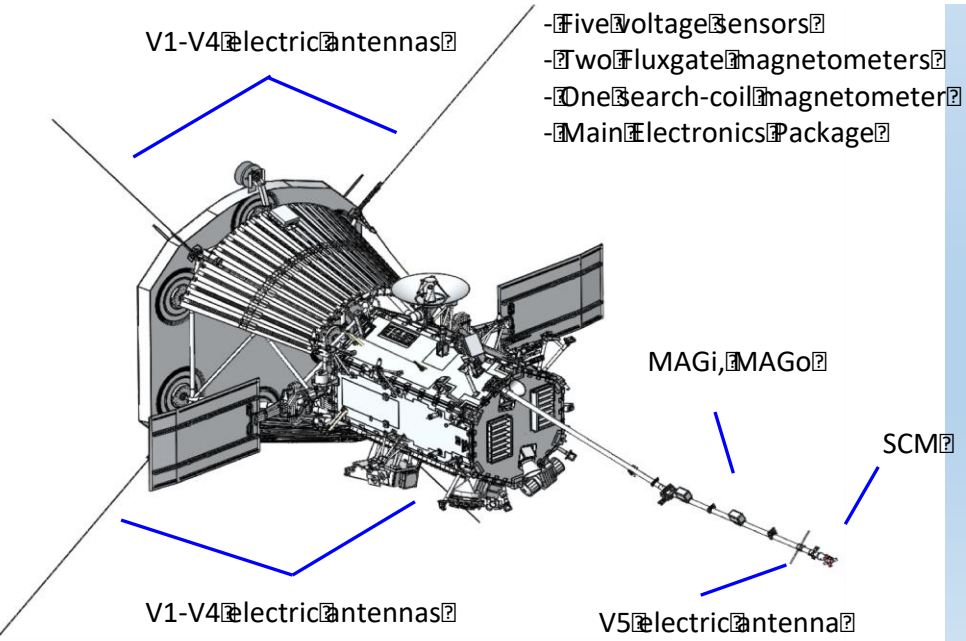
The Parker Solar Probe Carries Four Science Investigations

- **FIELDS (UC Berkeley, PI: S. Bale)**
- **ISʘIS (Princeton Univ., PI: D. McComas)**
- **SWEAP (Univ. Michigan/SAO, PI: J. Kasper)**
- **WISPR (Naval Res. Lab., PI: R. Howard)**

PSP/FIELDS



Bale *et al.*, Space Sci. Rev., 2016



FIELDS consists of five electric field antennas (four outside the s/c wake) and three magnetometers. It will measure electric and magnetic fields and waves, Poynting flux, absolute plasma density and density fluctuations, electron temperature, spacecraft floating potential, and radio emissions.

PSP/FIELDS Science

- How is energy from the lower solar atmosphere transferred to, and dissipated in, the corona and solar wind?
- What processes shape the non-equilibrium VDFs observed throughout the heliosphere?
- How do the processes in the corona affect the properties of the solar wind in the heliosphere?
- How does the magnetic field in the solar wind source regions connect to the photosphere and the heliosphere?
- Are the sources of the solar wind steady or intermittent?
- How do the observed structures in the corona evolve into the solar wind?
- What are the roles of shocks, reconnection, waves, and turbulence in the acceleration of energetic particles?
- What are the source populations and physical conditions necessary for energetic particle acceleration?
- How are energetic particles transported in the corona and heliosphere?

Bale *et al.*, Space Sci. Rev., 2016; Fox et al., Space Sci. Rev., 2016

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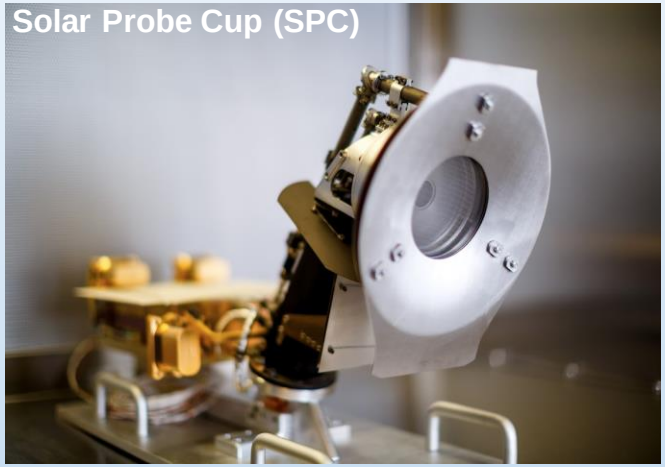
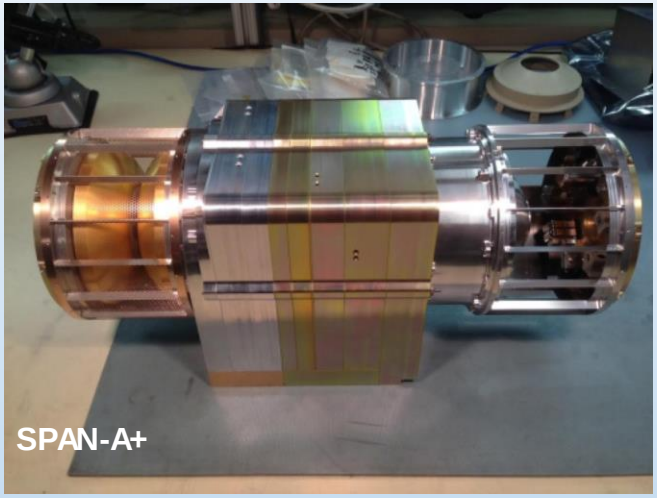
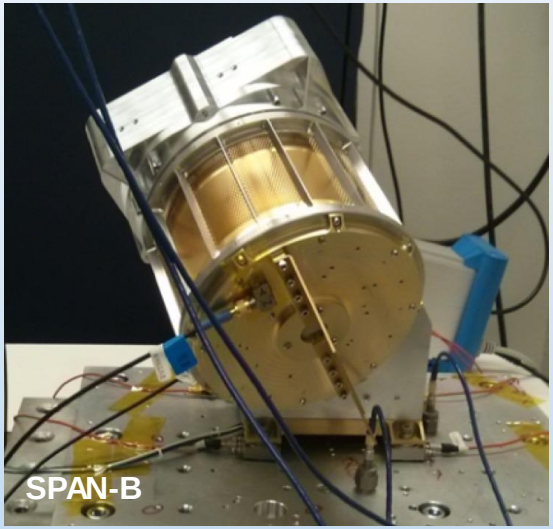
PSP/SWEAP







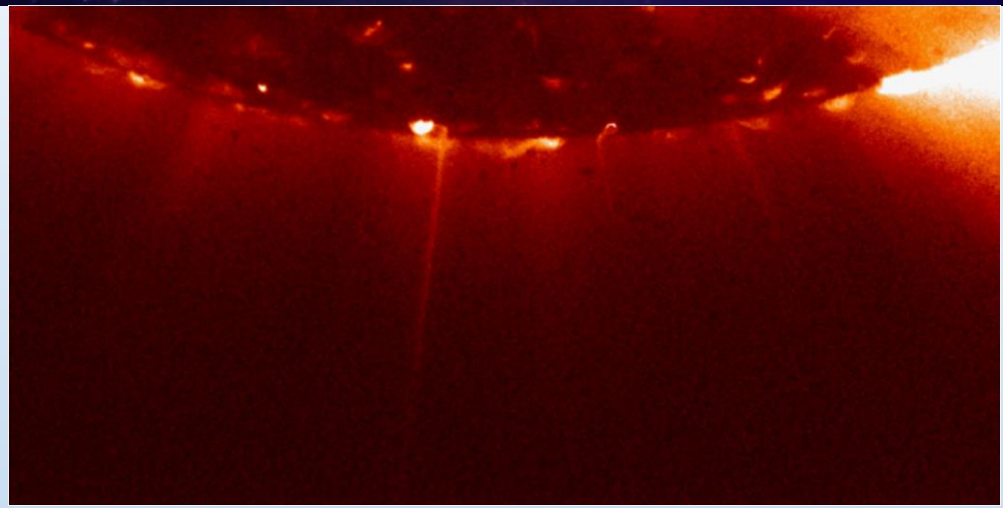
SWEAP consists of a Faraday Cup, an ion- and an electron electrostatic analyzer. It will measure electrons, protons, alphas, (and heavy ions) of the solar wind.

Kasper *et al.*, Space Sci. Rev., 2016

PSP/SWEAP Science

Sources of the solar wind:

- **Determine the structure and dynamics of the magnetic fields at the sources of the fast and slow solar wind.**



X-ray image of polar plumes

Heating the corona and solar wind:

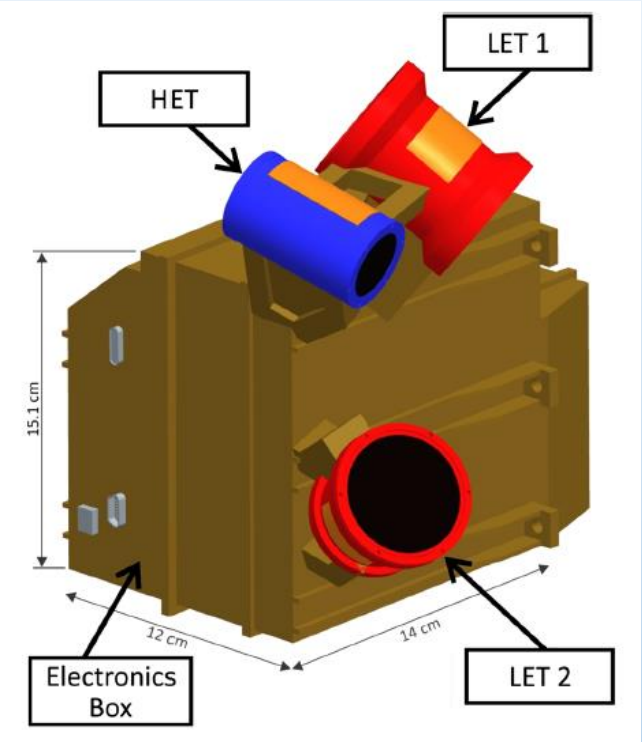
- **Trace the flow of energy that heats the solar corona and accelerates the solar wind.**

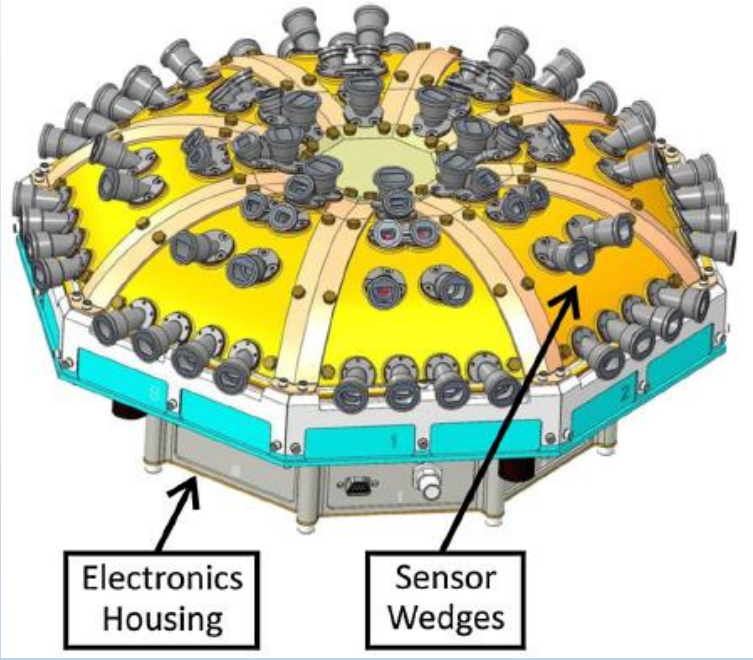
Acceleration and transport of energetic particles:

- **Explore mechanisms that accelerate and transport energetic particles.**

Kasper *et al.*, Space Sci. Rev., 2016

PSP/ISOIS

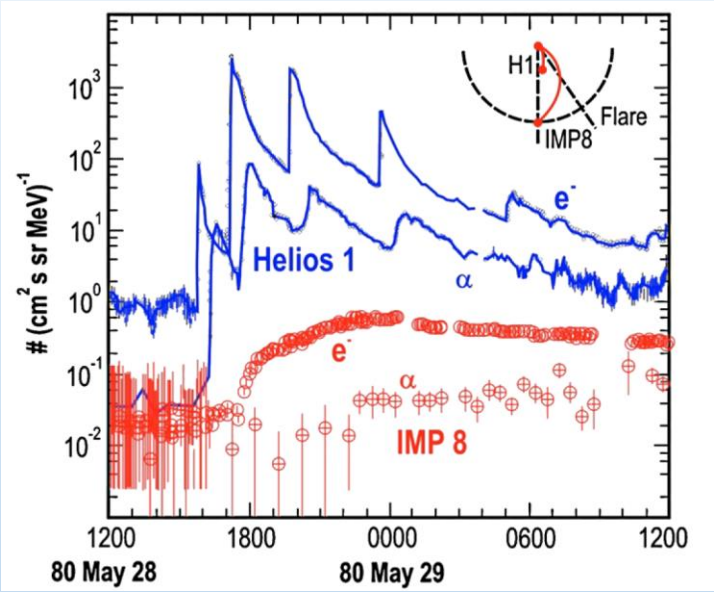


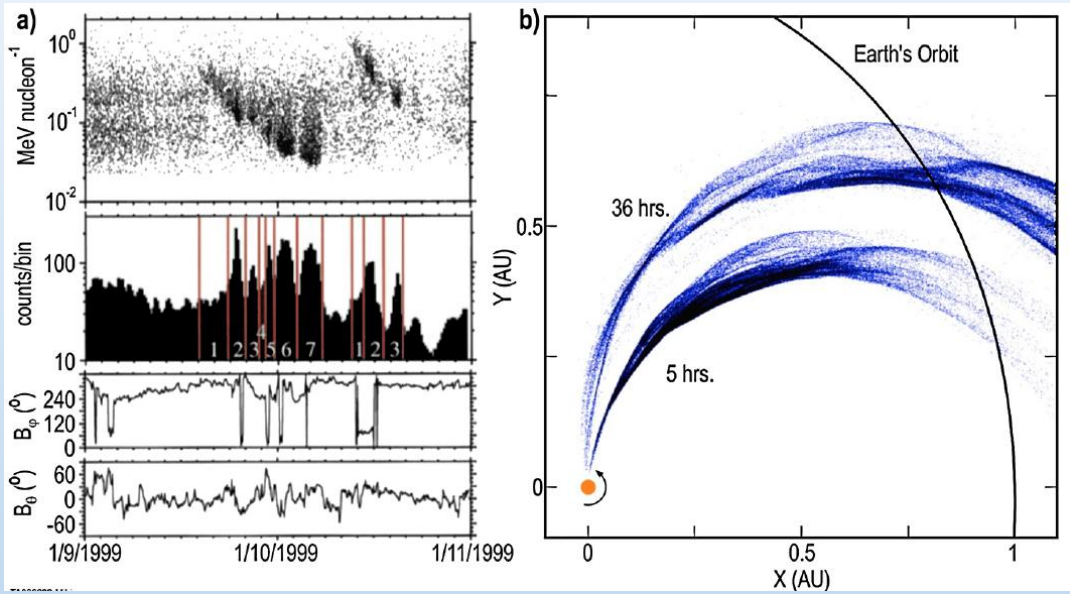


ISOIS consists of two main sensors, EPI-hi and EPI-lo. It will measure energetic electrons, protons and heavy ions within a kinetic energy range of 10s of keV to >50 MeV/n.

McComas *et al.*, Space Sci. Rev., 2016

PSP/ISOIS Science



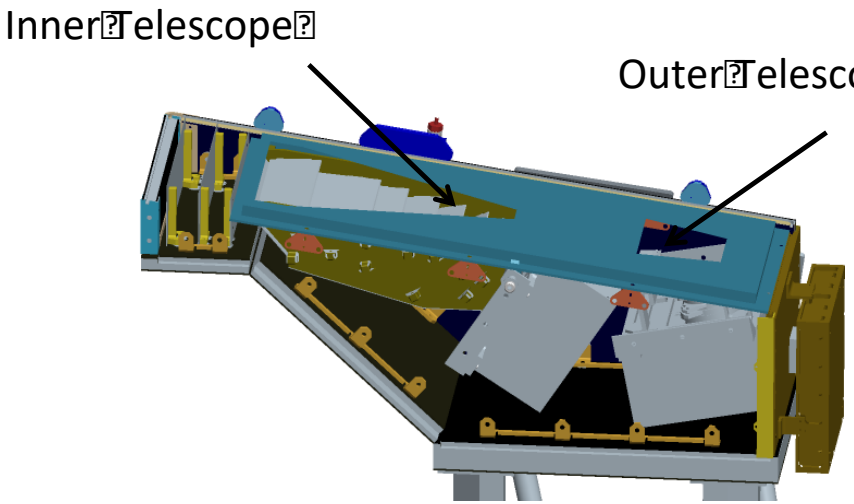


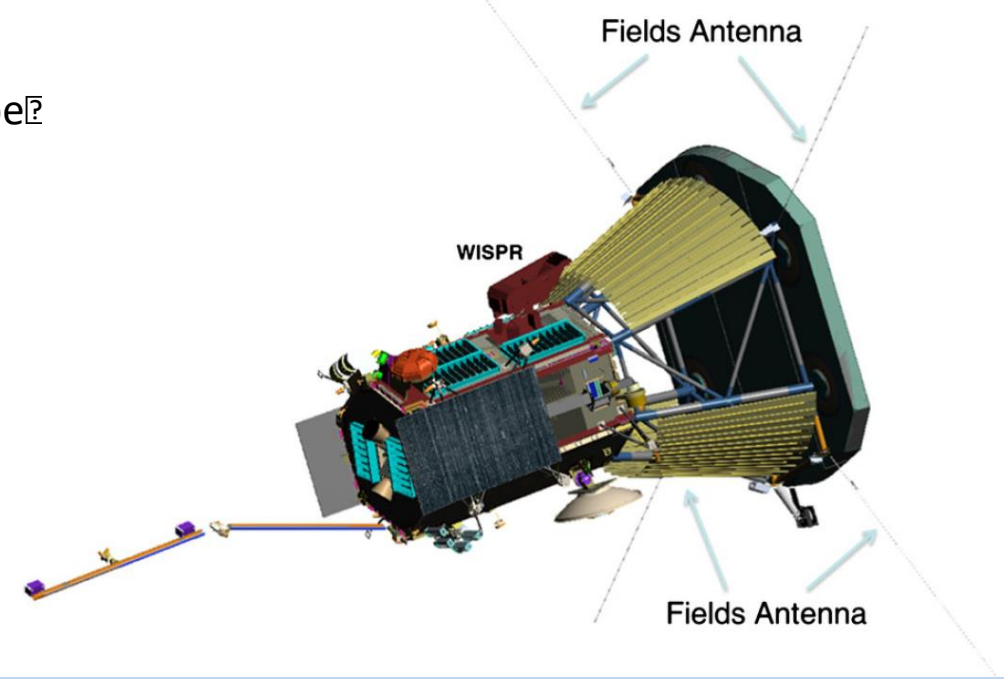
Explore the physical mechanisms that produce, accelerate, and transport energetic particles in the inner heliosphere:

- **What is the origin or seed population of solar energetic particles (SEPs)?**
- **How are these SEPs and other particle populations accelerated?**
- **What mechanisms are responsible for transporting the different particle populations into the heliosphere?**

McComas *et al.*, Space Sci. Rev., 2016

PSP/WISPR

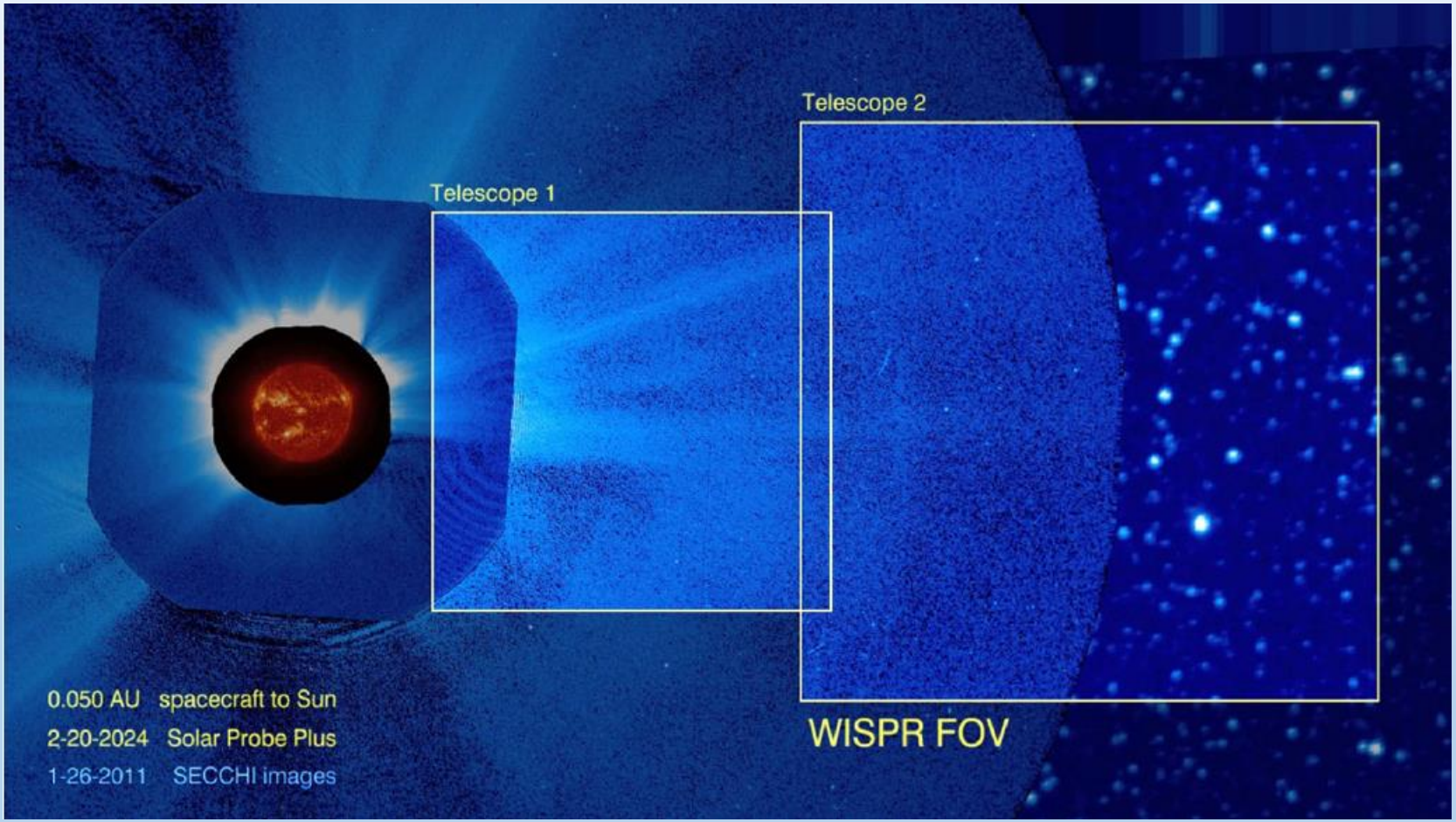




WISPR is a heliospheric imager that consists of two telescopes. It will image backscattered light from solar wind structures and dust particle populations.

Vourlidas *et al.*, Space Sci. Rev., 2016

PSP/WISPR



WISPR field of view at closest perihelion

Vourlidas *et al*., Space Sci. Rev., 2016

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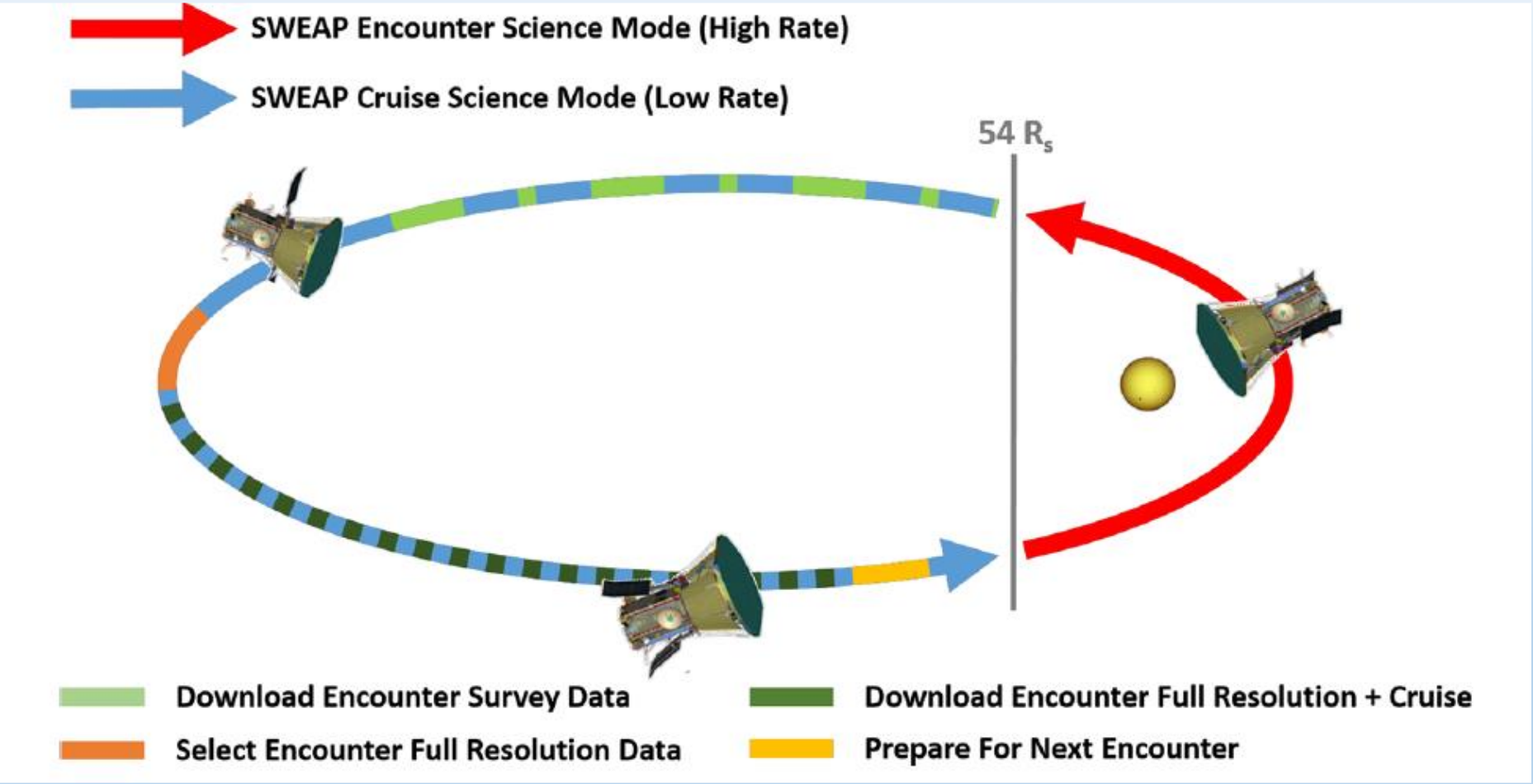
Operations Concept



Kasper *et al.*, Space Sci. Rev., 2016

PSP Data Availability

Parker Solar Probe adheres to the NASA Open Data Policy

Requirement: PSP PIs are responsible for delivery to a NASA approved data repository within six months from [end of] downlink of all data from a given encounter.

PSP Level-1 Science Requirements (2018)

Expectation: Encounter-1 Data will be available to the public by Nov. 1, 2019

New Initiative: WHC

For community comment:

“Whole Heliosphere Campaign”

- **Unique opportunity in Heliophysics allowing coordination in a way we have never done before**
- **Benchmark for integrated knowledge and assessment of knowledge gaps throughout the system**
- **Truly “interdisciplinary”**

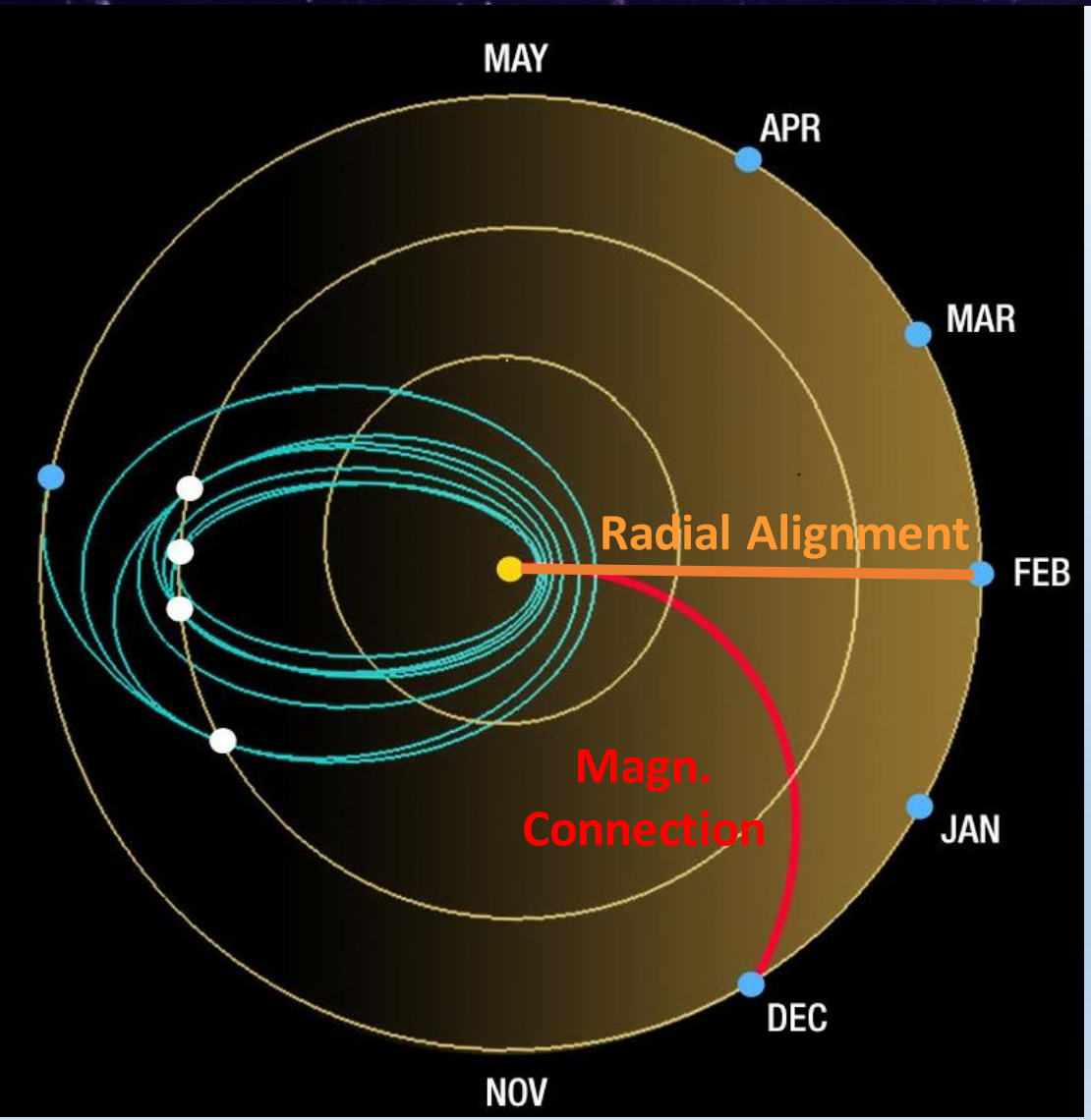
New Initiative: WHC

- Coordinated observation and theory-modeling program covering full breadth of Heliophysics across agencies and interdisciplinary
- Centered on perihelion passes for Parker which are visible from Earth or other planets
- Coordinate Parker, SDO, IRIS, Solar Orbiter, STEREO A, other space, suborbital & ground-based assets
- Track the transit of features through interplanetary space
- Observe and characterize the geospace response
- Integration of Theory and Modeling throughout solar system and beyond

New Initiative: WHC

- ”Test Runs” this year centered on Solar Minimum called Whole Heliosphere and Planetary Interactions led by G. De Toma, S. Gibson, and B. Thompson (https://whpi.hao.ucar.edu/)
- Novel interdisciplinary scientist program to drive connected research and discovery
  - Large scale IDS teams led by a PI
  - Awards for individual contributors who will provide their data and conduct independent research.
- Follow up workshop after first observing period
  - Collaboration after campaign plus planning meeting for the next campaign.
- Workshops would continue to be scheduled at a regular cadence – organized by IDS teams

PSP Science Coordination



Ecliptic Longitude of PSP Perihelia is Near-Constant.

Perihelia near mid-February would provide Near-Radial Alignment of PSP and Earth.

Perihelia near mid-December would allow Magnetic Connection between PSP and Earth

For Perihelia between mid-November and mid-May, the PSP Subsolar Point could be observed from Earth.

PSP Perihelia

Perih. #	Date	Solar Dist. [Rs]
1	Nov. 6, 2018	35.7
2*	April 4, 2019	35.7
3	Sept. 1, 2019	35.7
4	Jan. 29, 2020	27.9
5*	June 7, 2020	27.9
6	Sept. 27, 2020	20.4
7	Jan. 17, 2021	20.4
8*	Apr. 29, 2021	16.0
9	Aug. 9, 2021	16.0
10	Nov. 21, 2021	13.3
11*	Feb. 25, 2022	13.3
12*	June 1, 2022	13.3

Perih. #	Date	Solar Dist. [Rs]
13	Sept. 6, 2022	13.3
14*	Dec. 11, 2022	13.3
15*	Mar. 17, 2023	13.3
16	June 22, 2023	13.3
17	Sept. 27, 2023	11.4
18*	Dec. 29, 2023	11.4
19*	Mar. 30, 2024	11.4
20	June 30, 2024	11.4
21	Sept. 30, 2024	11.4
22*	Dec. 24, 2024	9.9
23*	Mar. 22, 2025	9.9
24	June 19, 2025	9.9

Near-Radial Perihelion Alignment of PSP and Earth (*PSP/STEREO A)

Magnetic Connection between PSP Perihelion and Earth (*PSP/STEREO A)

PSP Perihelion Subsolar Point could be observed from Earth (*PSP/STEREO A)

PSP Perihelion Subsolar Point not observable from Earth