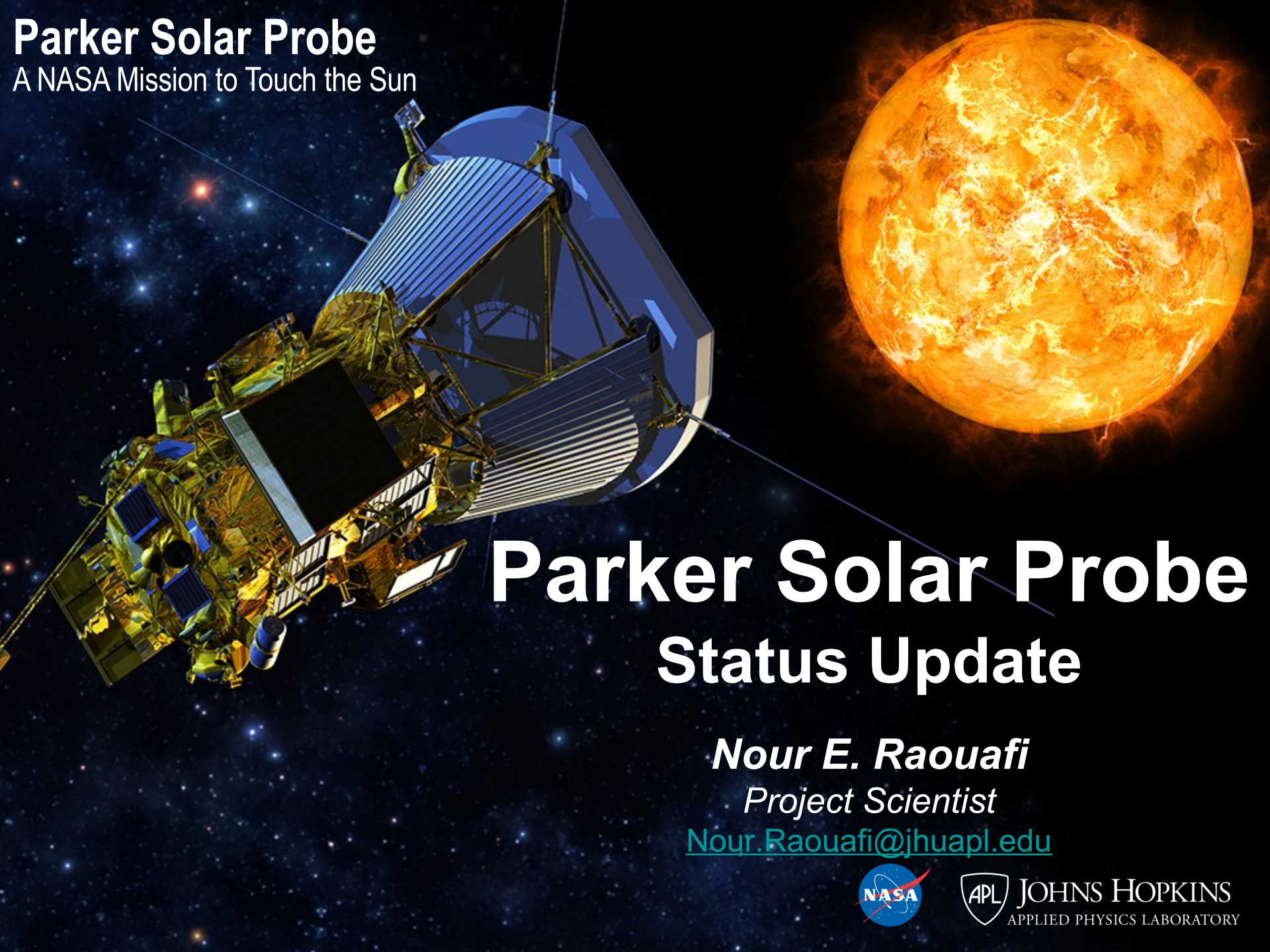


Parker Solar Probe
Status Update

Nour E. Raouafi
Project Scientist
Nour.Raouafi@jhuapl.edu

NASA

APL JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

Parker Solar Probe
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.**

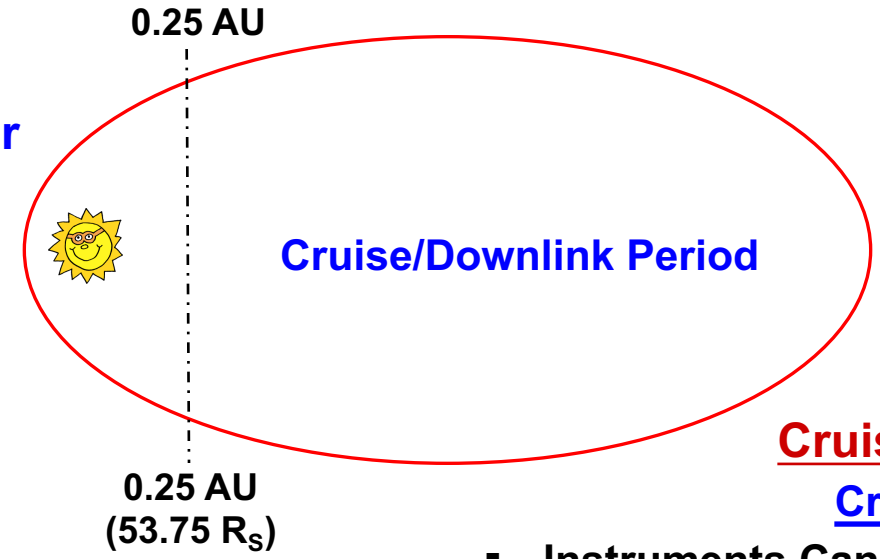
Detailed Science Objectives

- **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.**
  - **Level 1 Mission and Measurement Requirements have been derived in order to achieve these science objectives**
  - There are three detailed science sub-questions stemming from each objectives ….

Brief Summary of Recent Events & Future Activity

- Parker Solar Probe was launched from Kennedy Space Center in the early morning of August 12, 2018 (3:31 a.m. EDT)
  - See http://parkersolarprobe.jhuapl.edu for more info. & graphics
- Commissioning activities have been successfully completed.
- Spacecraft operations are nominal and instruments operating as expected. All is well with PSP.
- First light data from the four PSP Investigation Teams were released on 19 Sep
  - See https://svs.gsfc.nasa.gov/13072
- PSP had its first Venus gravity assist (VGA) flyby on October 3rd; science data taken but not yet fully analyzed & released
- Solar Encounter #1 (Encounter Readiness Review on 19 Oct)
  - Entry: 0.25 AU inbound, 31 Oct (DOY 304), 12:00 GMT
  - Perihelion: 0.166 AU (35.7 Rs), 06 Nov (DOY 311), 03:30 GMT
  - Exit: 0.25 AU outbound, 11 Nov (DOY 315), 19:00 GMT
- PSP Science Working Group Meeting #16, 6-7 Nov, UC Berkeley
- First encounter science data downlink via DSN Ka band: 07 Dec
- Two PSP Sessions at Fall 2018 AGU Meeting, Washington, DC

Orbital Operations Concept



Solar Encounter Period

Encounter Operations

- Primary science data collection phase – All instruments will be powered on
- Fanbeam antenna periodically available for communications & Nav
- No SSR Playbacks

Cruise/Downlink Period

Cruise Operations

- Instruments Can Be Powered On (R < 0.82 AU)
- Instruments off during some activities
- Fanbeam for communications – H/K data only
- Commanding as needed to support spacecraft maintenance

Science Downlink Operations

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

Schedule of PSP Mission Perihelia & Venus Flybys

2018

- August 12, 2018: Launch - 3:31 a.m. EDT (7:31 UTC)
- October 3, 2018: Venus Flyby #1 - 4:44 a.m. EDT (8:44 UTC)
- November 5, 2018: Perihelion #1 - 10:27 p.m. EST (Nov. 6, 2018 at 03:27 UTC)

2019

- April 4, 2019: Perihelion #2
- September 1, 2019: Perihelion #3
- December 26, 2019: Venus Flyby #2

2020

- January 29, 2020: Perihelion #4
- June 7, 2020: Perihelion #5
- July 11, 2020: Venus Flyby #3
- September 27, 2020: Perihelion #6

2021

- January 17, 2021: Perihelion #7
- February 20, 2021: Venus Flyby #4
- April 29, 2021: Perihelion #8
- August 9, 2021: Perihelion #9
- October 16, 2021: Venus Flyby #5
- November 21, 2021: Perihelion #10

2022

- February 25, 2022: Perihelion #11
- June 1, 2022: Perihelion #12
- September 6, 2022: Perihelion #13
- December 11, 2022: Perihelion #14

2023

- March 17, 2023: Perihelion #15
- June 22, 2023: Perihelion #16
- August 21, 2023: Venus Flyby #6
- September 27, 2023: Perihelion #17
- December 29, 2023: Perihelion #18

2024

- March 30, 2024: Perihelion #19
- June 30, 2024: Perihelion #20
- September 30, 2024: Perihelion #21
- November 6, 2024: Venus Flyby #7 - Final Venus Flyby
- December 24, 2024: Perihelion #22 First Closest Approach

2025

- March 22, 2025: Perihelion #23
- June 19, 2025: Perihelion #24

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Parker Solar Probe
Launch & Mission Design Overview

Launch
- Aug. 12, 2018

Trajectory Design
- 24 Orbits
- 7 Venus GA flybys

Mission Lifetime
- 6 years, 11 months

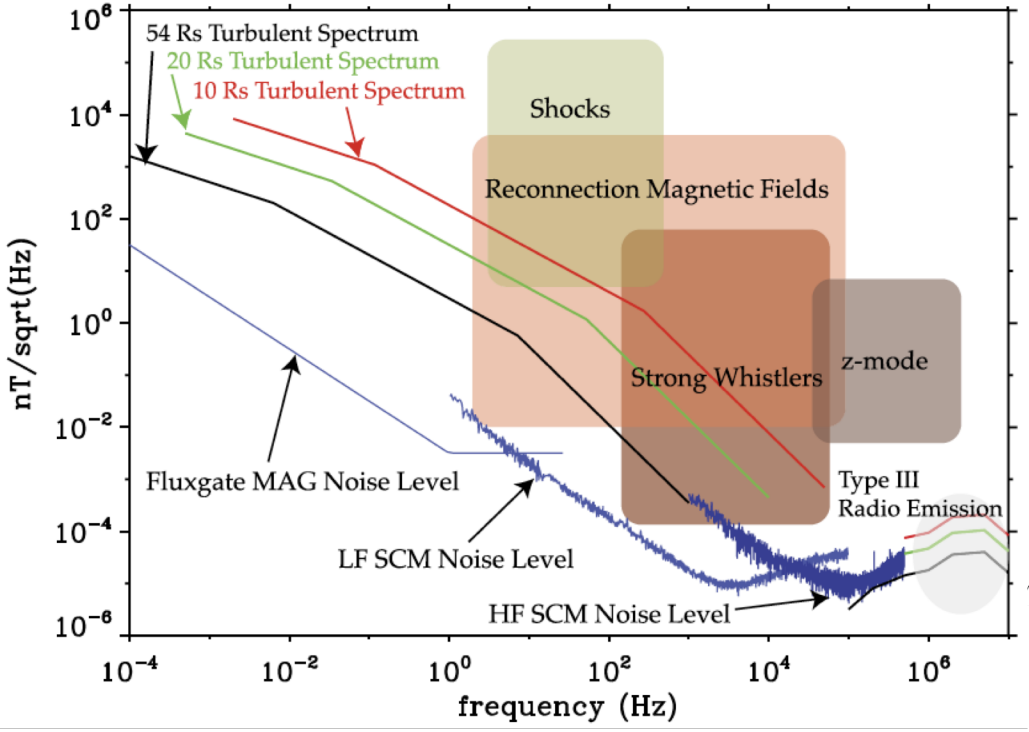
First Orbit
- Perihelion 35 $R_\odot$
- ~~L0+30 days: S/C commissioning~~
- ~~L30+25 days: payload commissioning~~
- Oct. 31 – Nov. 11: first encounter
- Dec. 3-8: first data downlink

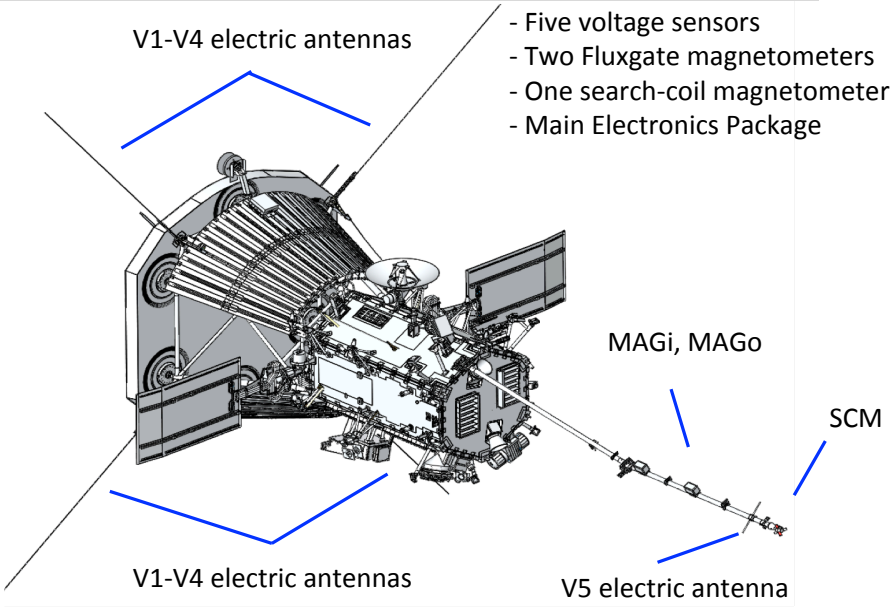
JOHNS HOPKINS APPLIED PHYSICS LABORATORY

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

FIELDS: Some commissioning data

PI: Stuart Bale (Univ. California, Berkeley)

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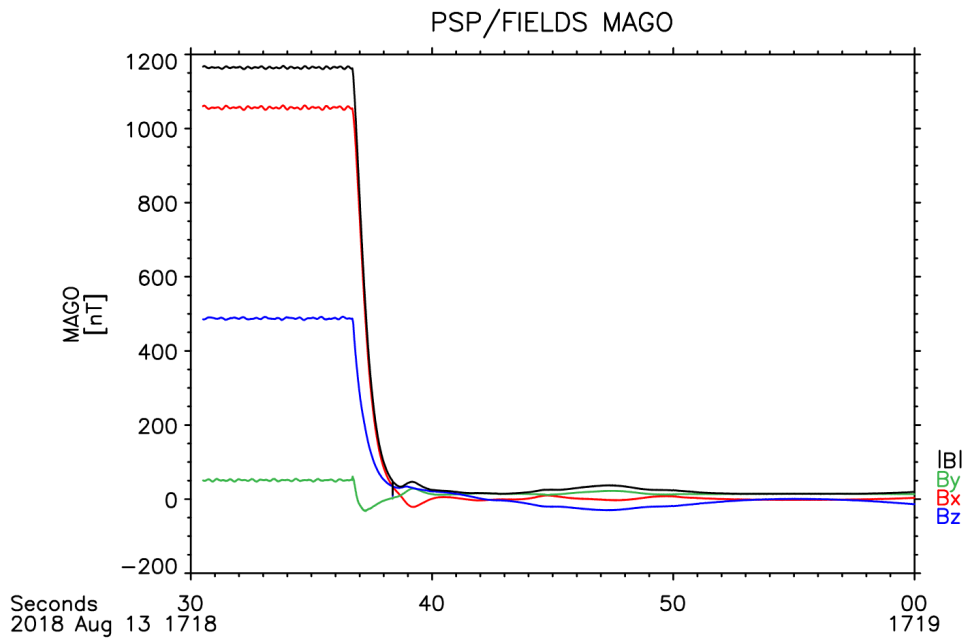
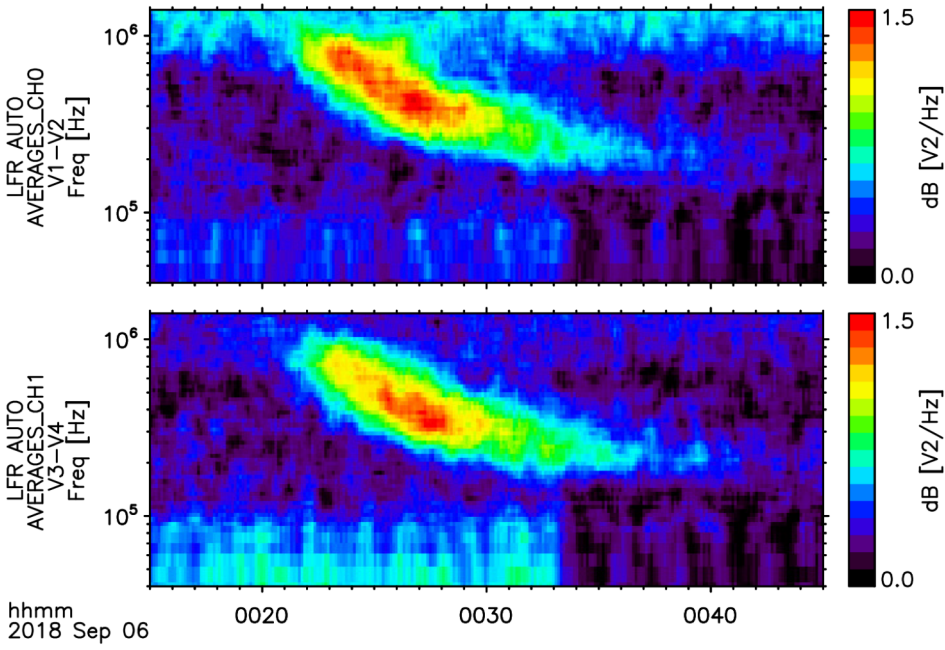


Measured magnetic fields as the boom swings away from PSP (from outboard fluxgate MAG)



First PSP Type-III radio burst from a solar flare (from two pairs of whips)

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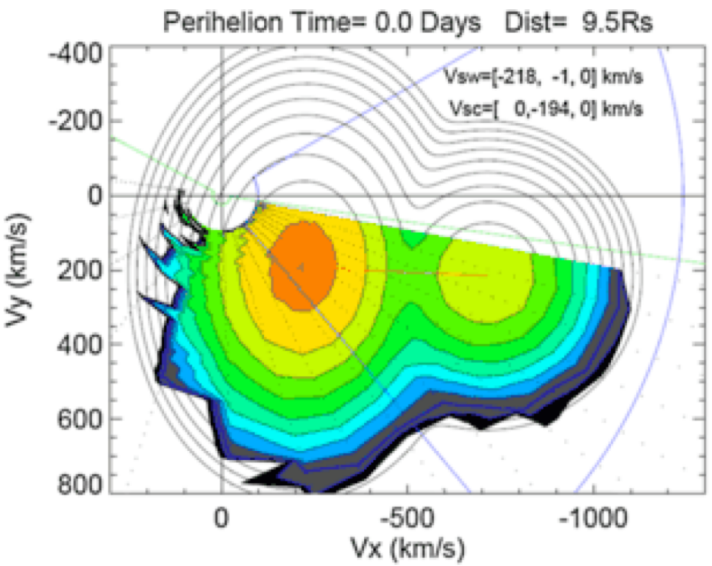
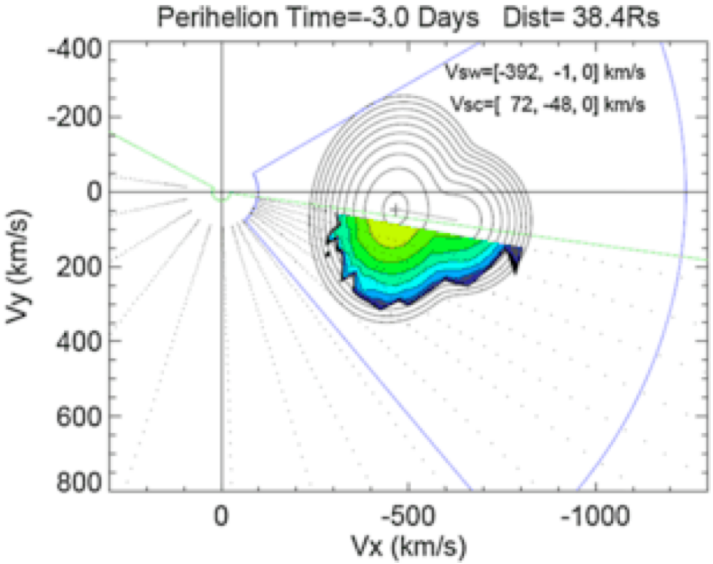
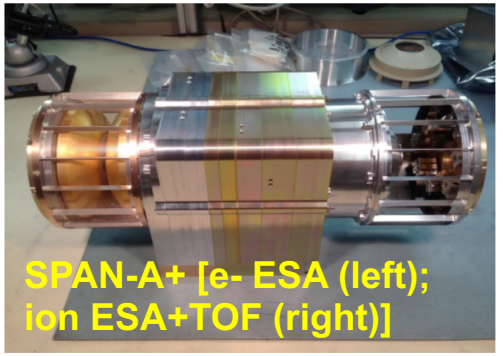
SWEAP: Solar Wind Electron Alphas and Protons

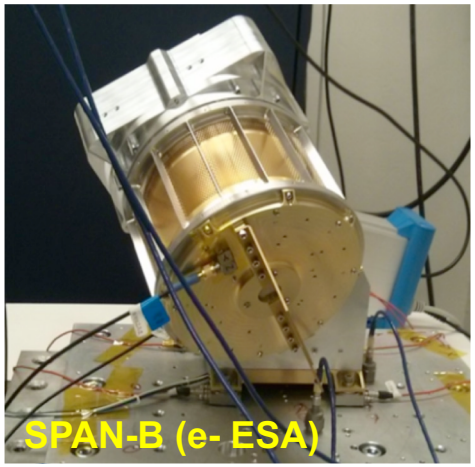
PI: Justin Kasper (Univ. Michigan/SAO)

SWEAP will measure velocity distributions (velocity, density, & temperature) of electrons, protons, alphas, (and heavy ions).









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

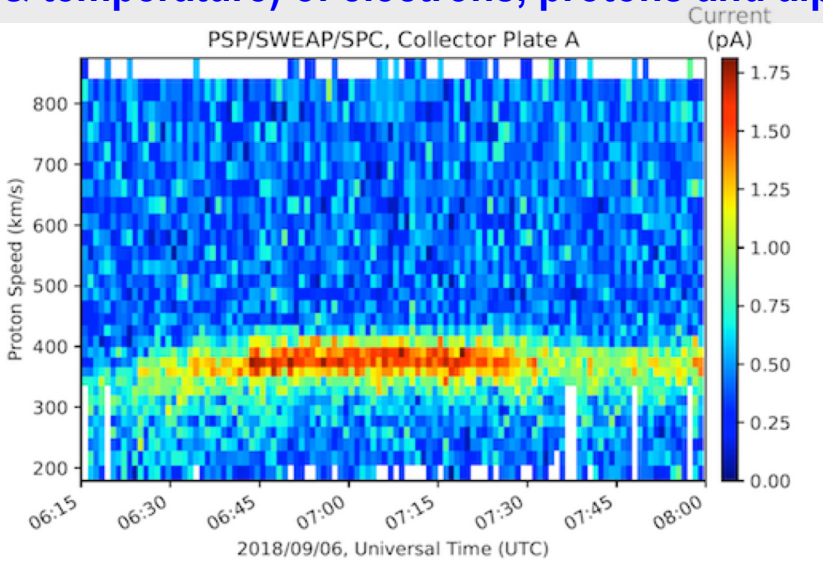
SWEAP: Solar Wind Electron Alphas and Protons [Some commissioning data]

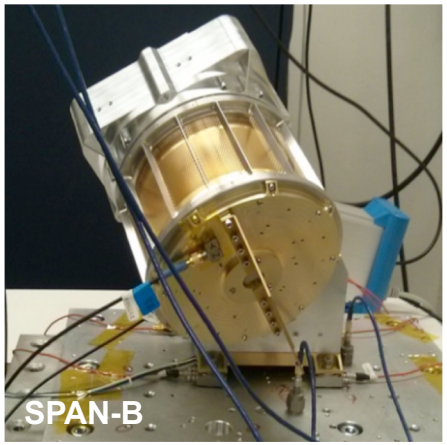
PI: Justin Kasper (Univ. Michigan/SAO)

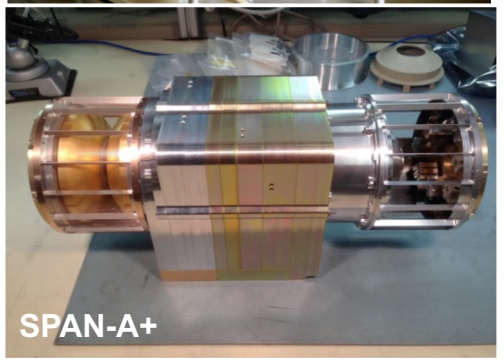
SWEAP will measure velocity distributions (velocity, density, & temperature) of electrons, protons and alphas.

SWEAP Solar wind measurements (slew)

SPC

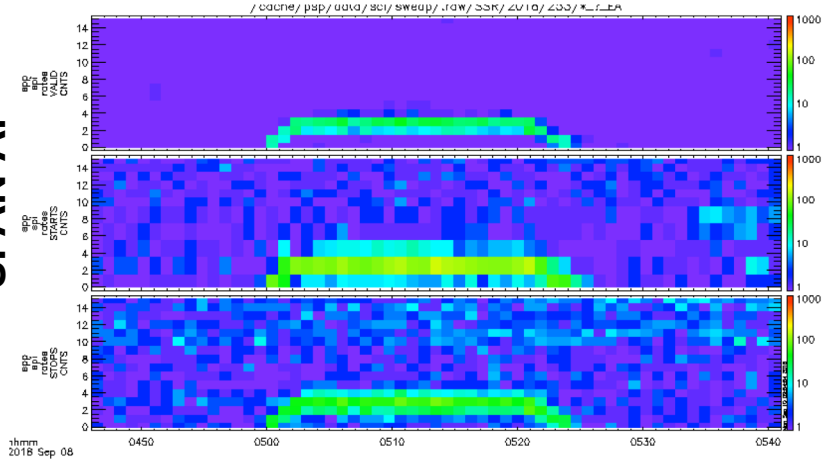


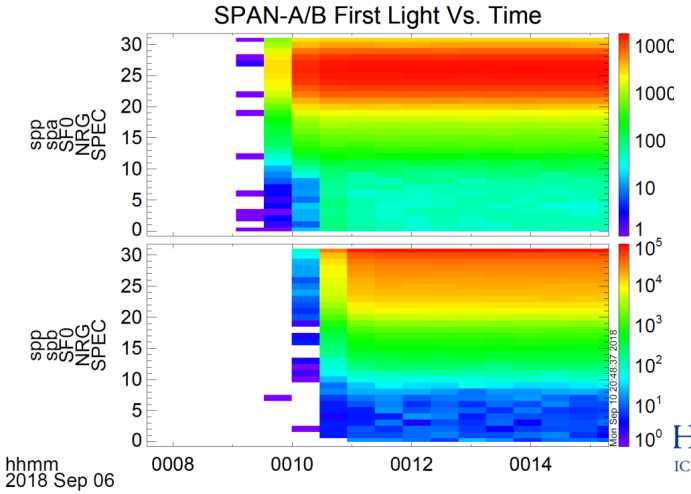




SWEAP Solar wind measurements (slew)

SPAN-Ai





Electron

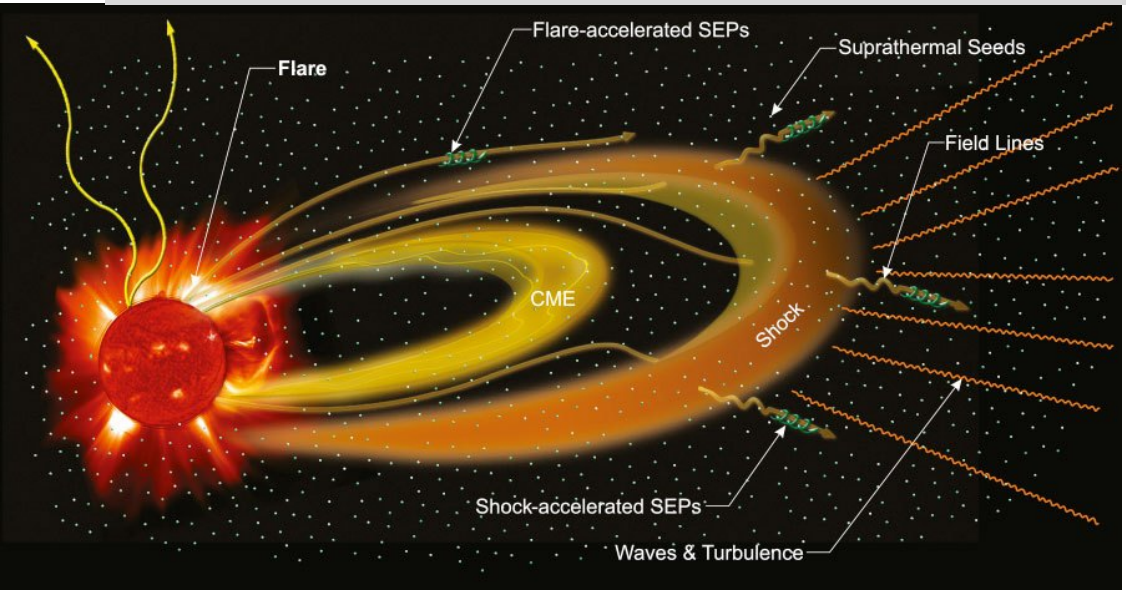
SPAN-A/B

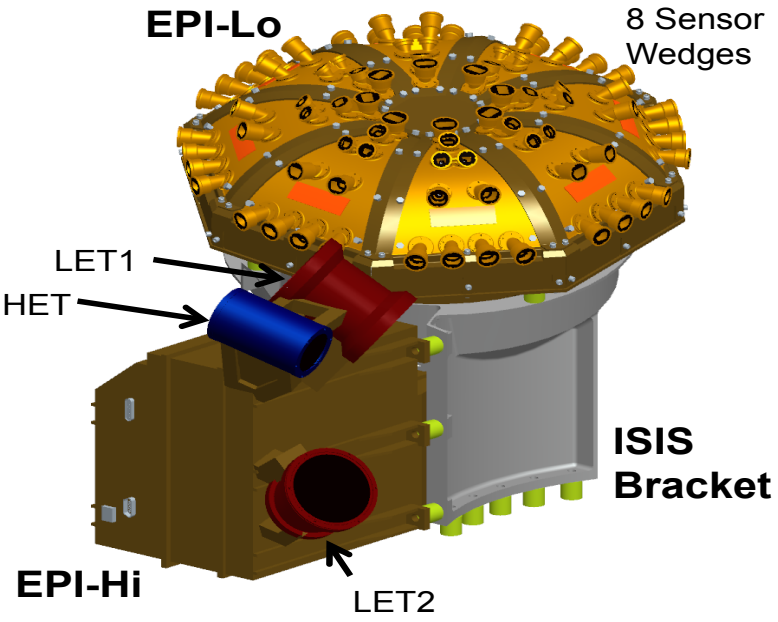
HOPKINS ICS LABORATORY

ISOIS: Integrated Science Investigation of the Sun

PI: David McComas (Princeton Univ./SwRI)

ISOIS will measure energetic electrons, protons and heavy ions within the energy range 10s of keV to 100 MeV and correlates them with solar wind and coronal structures.





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

ISOIS: Integrated Science Investigation of the Sun [Some commissioning data]

PI: David McComas (Princeton Univ./SwRI)

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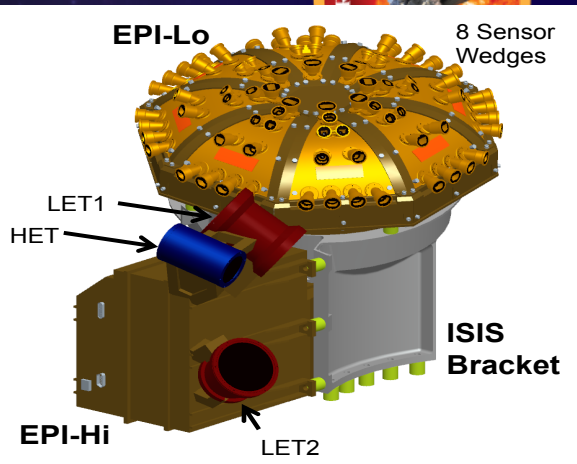
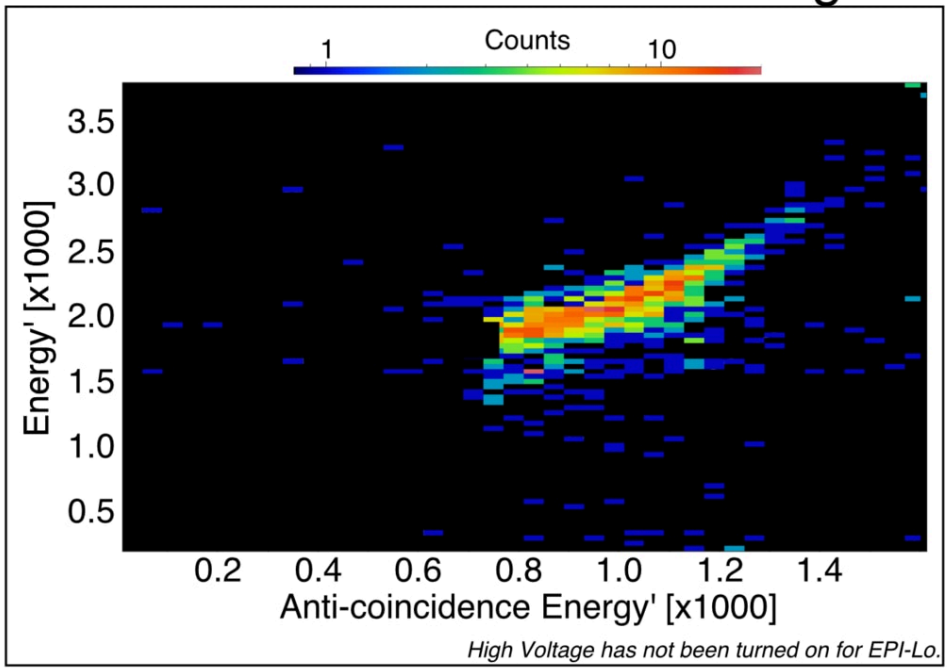
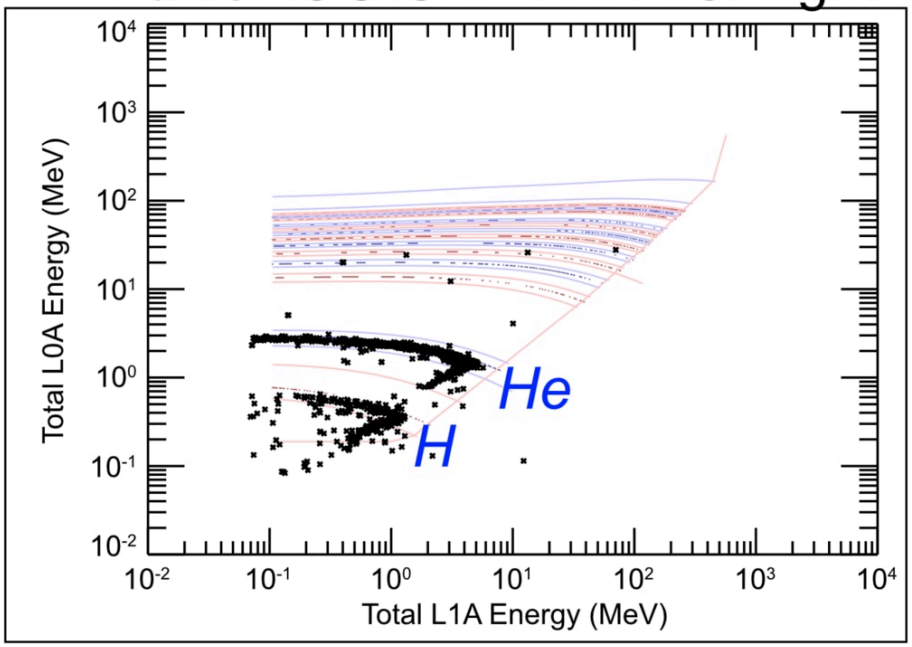


Parker ISOIS/EPI-Lo First Light



Parker ISOIS/EPI-Hi First Light

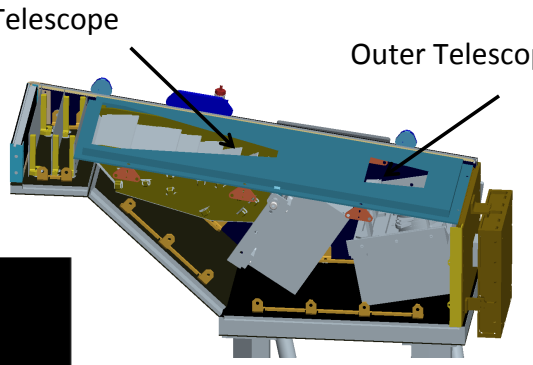


EPI-Lo: background cosmic rays

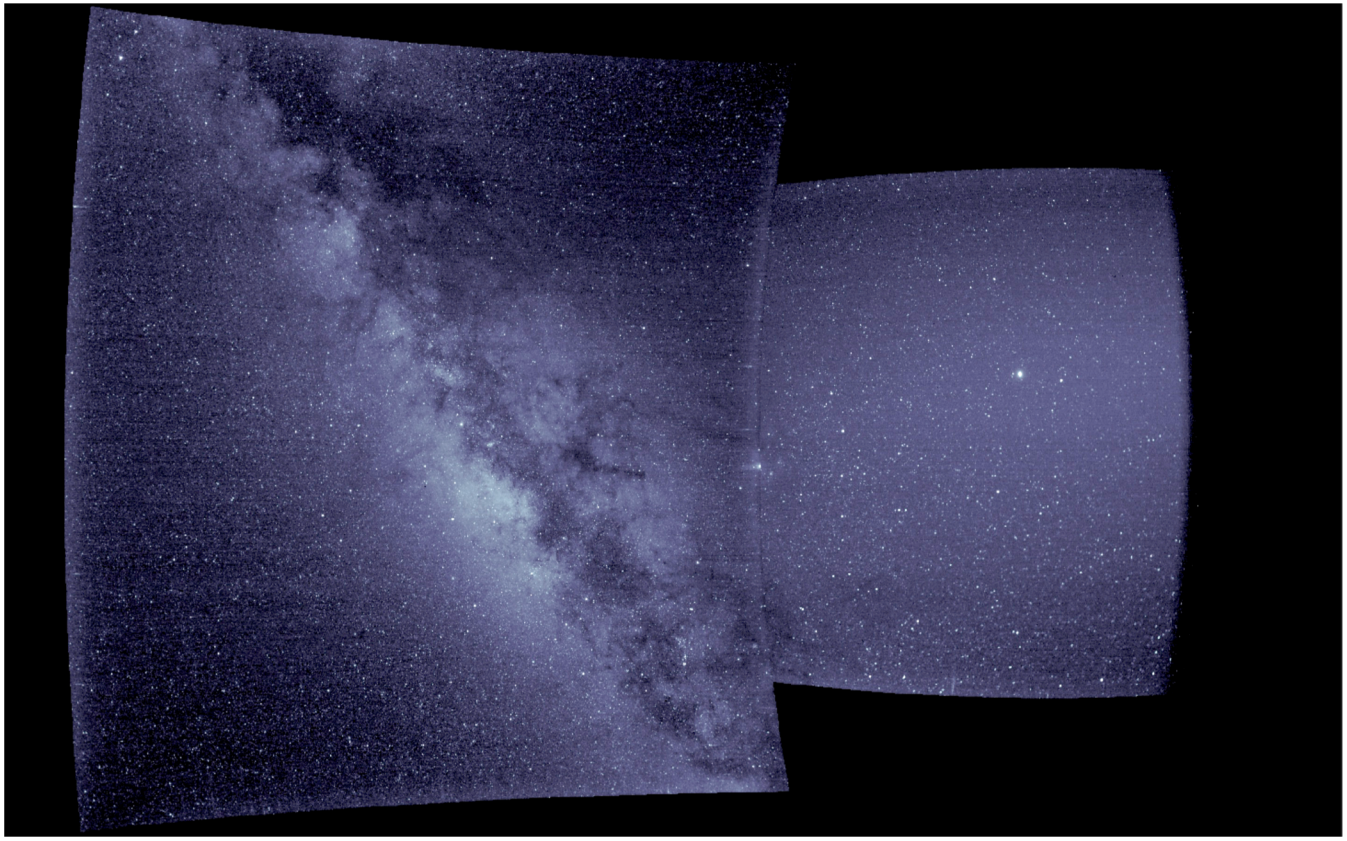
EPI-Hi: hydrogen and helium particles from the lower-energy telescopes

WISPR: Wide-Field Imager for Solar Probe Plus [Some commissioning data]

PI: Russ Howard (NRL)



WISPR will image of the solar wind, CMEs, shocks and other structures as they approach and pass the spacecraft.



First WISPR images after the door deployment (during 45º s/c slew)

Inner Telescope: Star field (right) – The bright object is Jupiter

Outer Telescope: Milky Way (left)

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Parker Solar Probe Looks Back at Home

NASA

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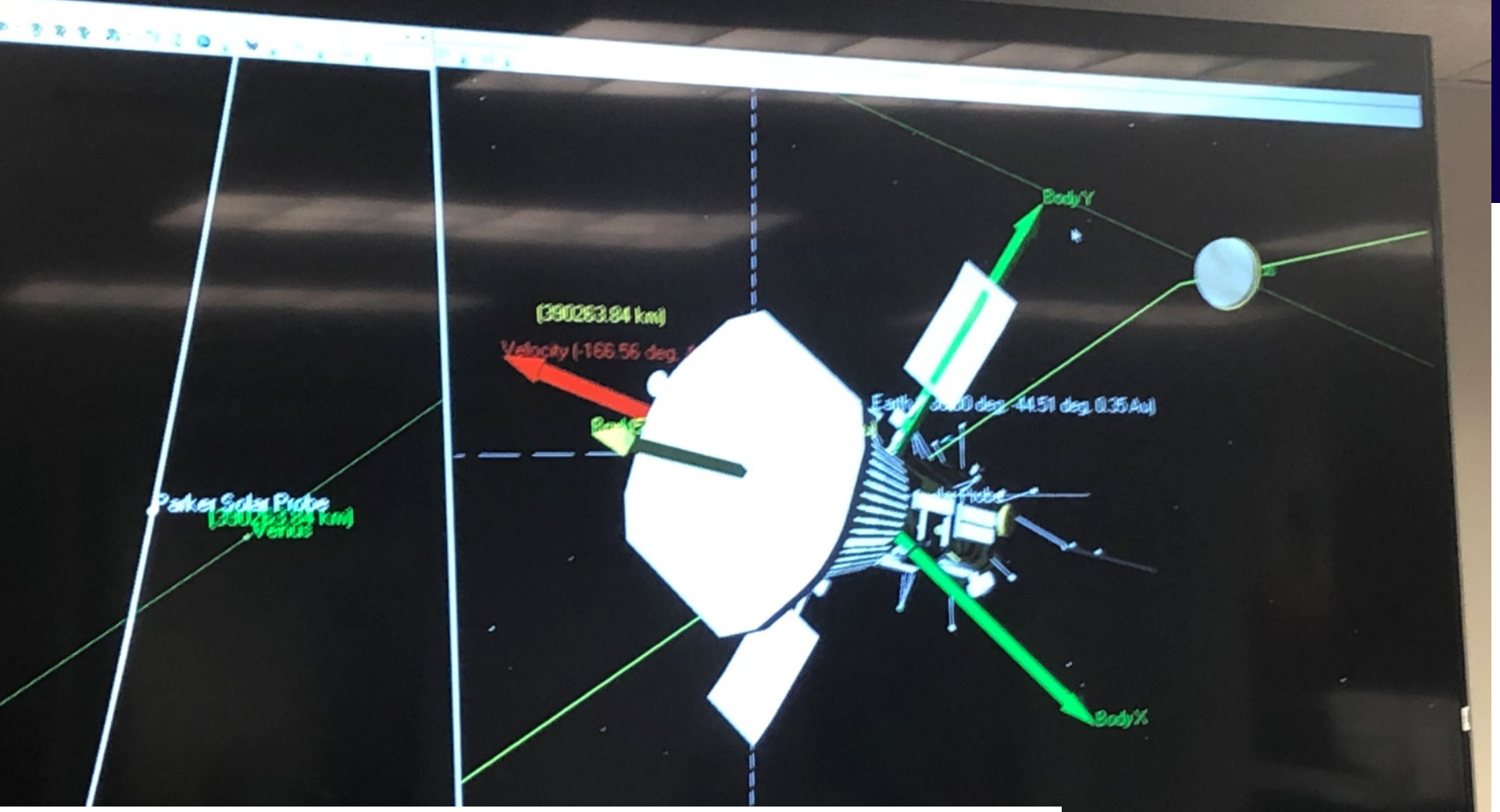
Parker Solar Probe
Venus Flyby – October 3, 2018



- **Record: shortest time (52 days) for an interplanetary journey from Earth to a planet**

- **350 meters off target**
- **δV < 1 second from target**
- **δV = 3.1 km/s & less than 1 m/s off target**

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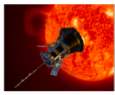
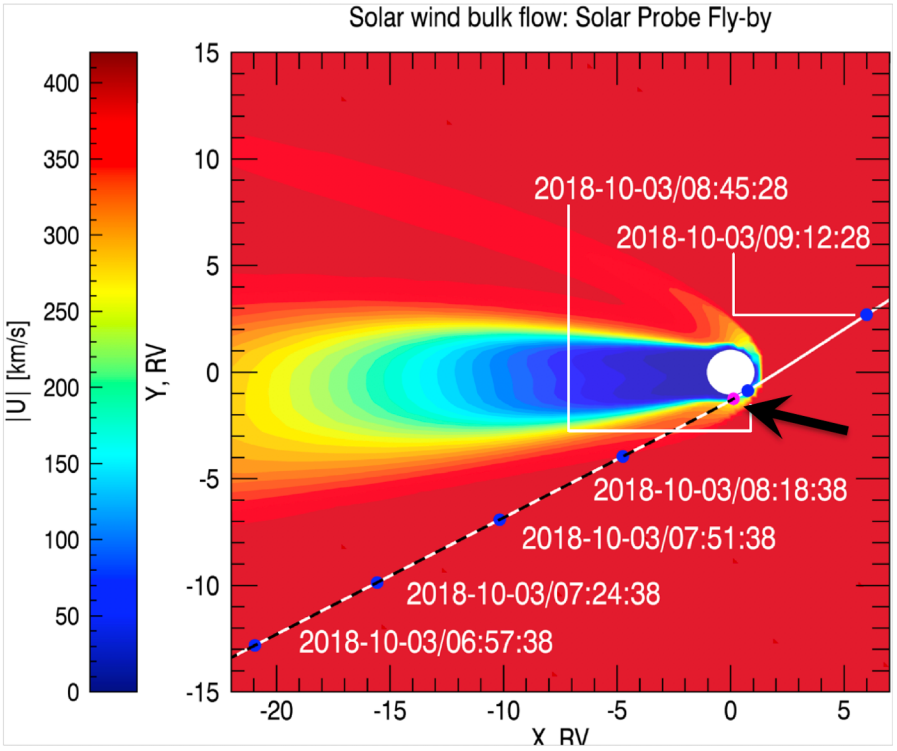
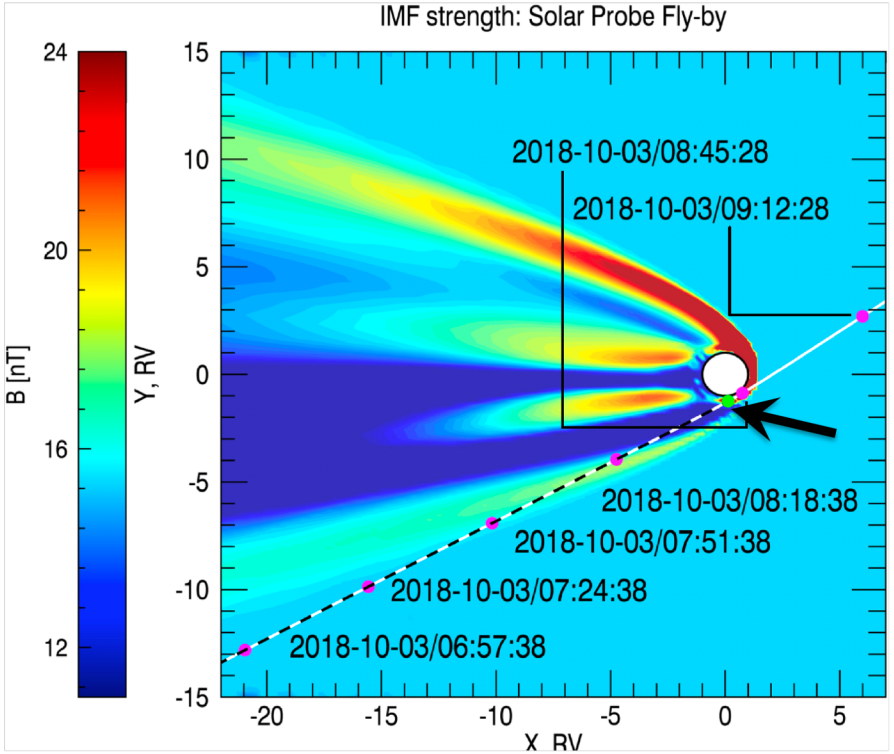
Venus Flyby – Science



The S/C went into safemode roughly 3 mins before closest approach ~2018-10-03/08:42:28





Times in UTC

smcurry@berkeley.edu

NASA

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Parker Solar Probe
First Encounter

1. Nov. 2: Beacon Tone “A”
2. Nov. 3: Beacon Tone “A”
3. Nov. 5 6:00pm EST: Beacon Tone “A”
4. Nov. 5 10:27pm EST: First Perihelion 35.7 Rsun
5. Nov. 7: Beacon Tone “A”
6. Nov. 10: Beacon Tone “A”
7. Nov. 12: Beacon Tone “A” (was not expected)

Nov. 16: first X-band track – Data downlink

- Spacecraft health and safety
- Data volumes per instrument
- SSR directory listing: prepare science
- data downlink in December

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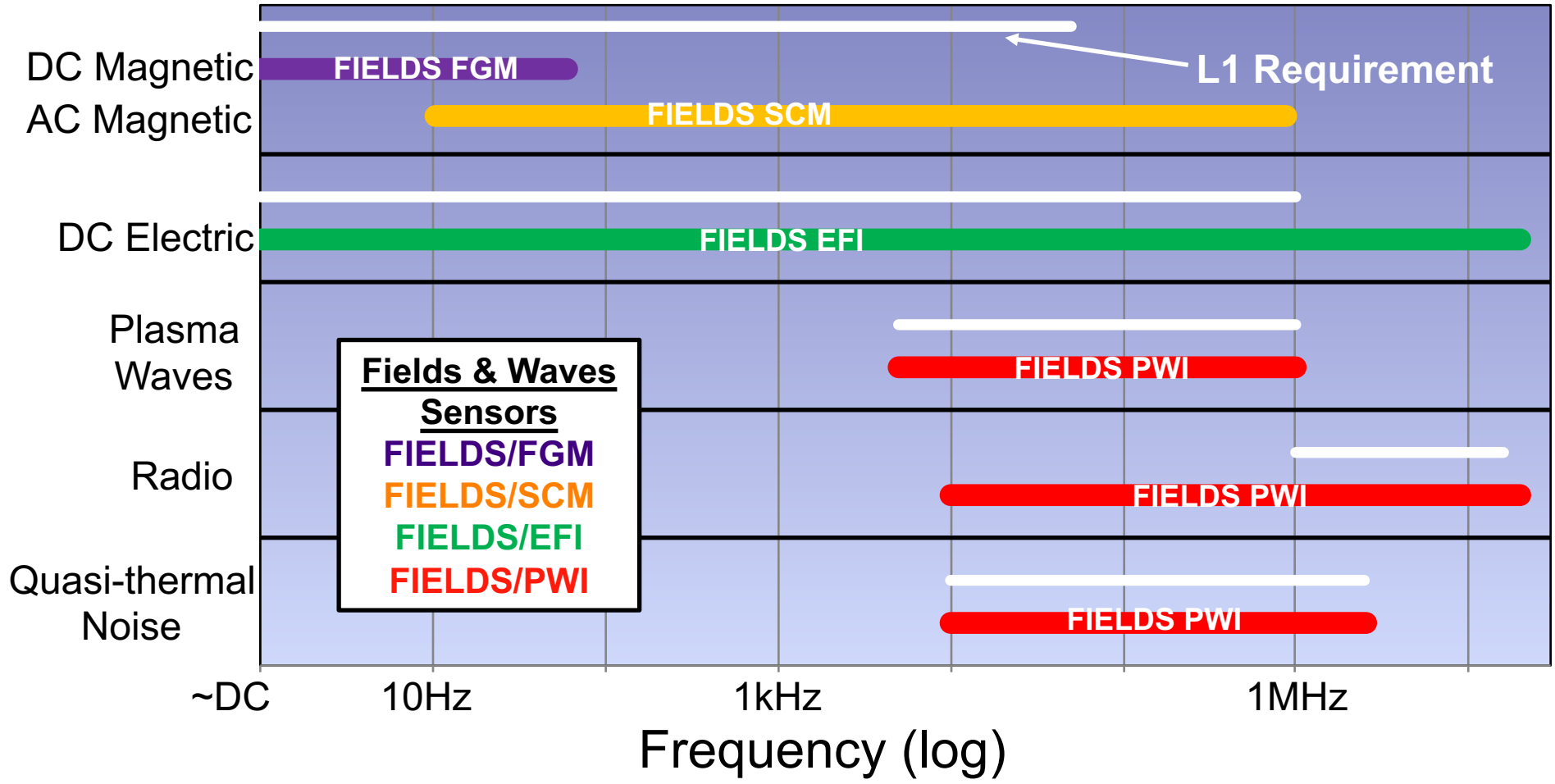
Parker Solar Probe

SPICE kernels, Predicts [short & long], ephemeris

https://sppgway.jhuapl.edu/ancil_products

Fields & Waves Instrument capabilities meet Level 1 requirements with margin



Particle Instrument capabilities meet Level 1 requirements with margin