

# Parker Solar Probe Mission Ground Systems Architectures Workshop February 26, 2019

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## Parker Solar Probe

*A NASA Mission to Touch the Sun*

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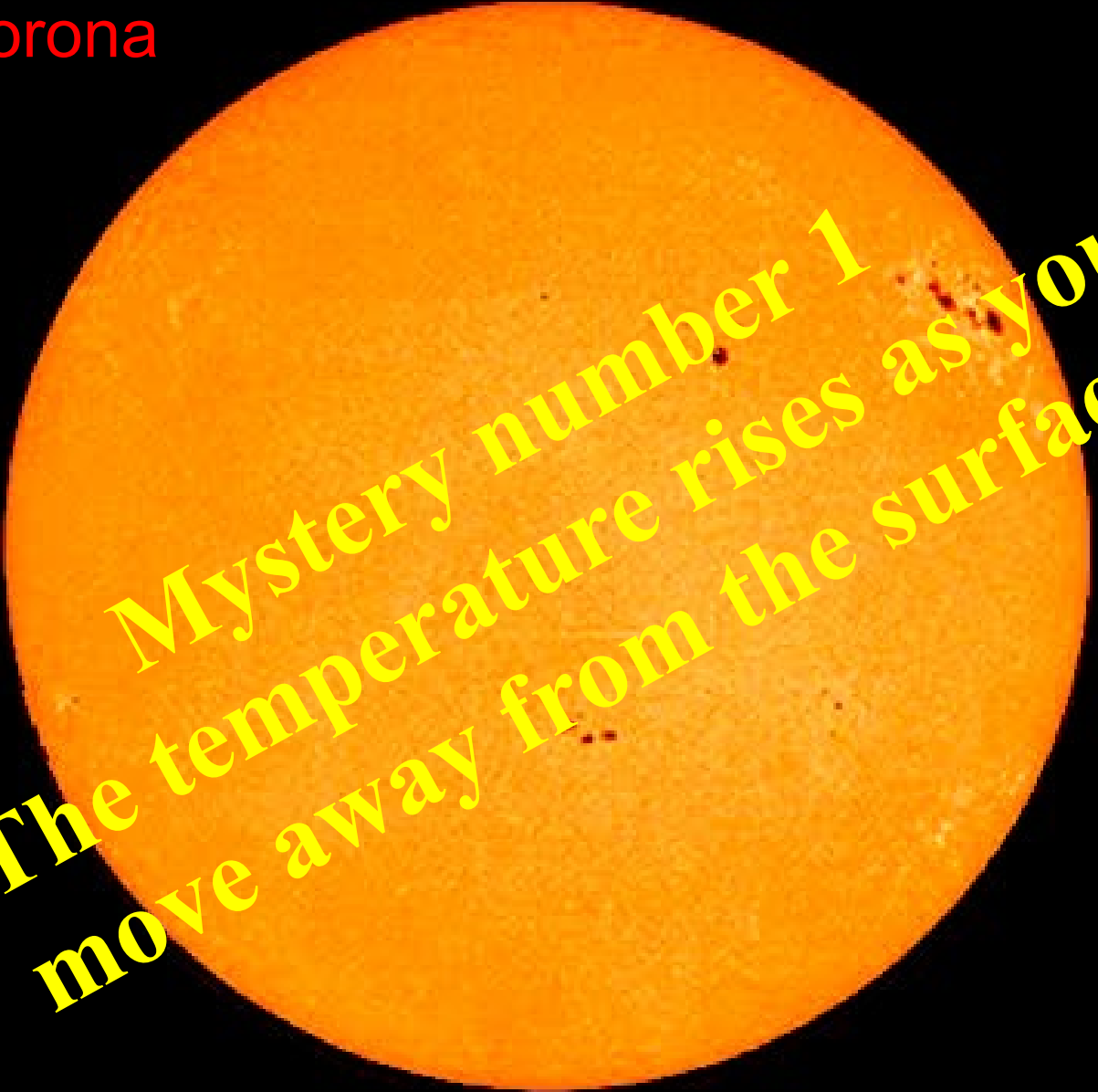


# The Mysterio





## The Mysterious Corona



**Mystery number 1**  
**The temperature rises as you**  
**move away from the surface!**

6,000 degrees K



# Discovery of the Solar Wind

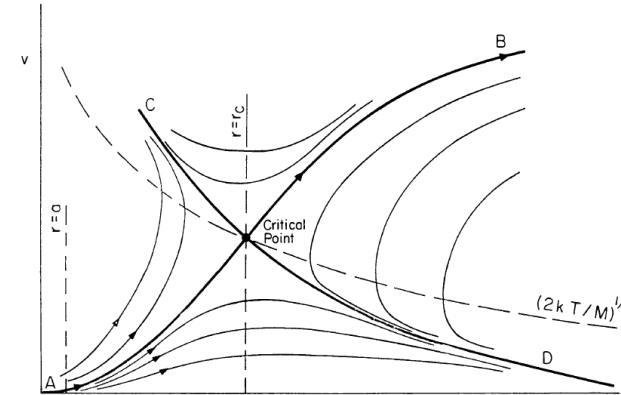


**Parker (1958):** hydrodynamic theory of the expanding solar corona

Prediction of a supersonic flow from the Sun toward the interplanetary medium



$$\begin{aligned}\nabla \cdot (\rho \mathbf{V}) &= 0, \\ \rho(\mathbf{V} \cdot \nabla) \mathbf{V} &= -\nabla p + \rho \mathbf{g}, \\ p &= \rho R T, \\ T &= T_0.\end{aligned}$$



**Neugebauer & Snyder, Science, 138, 1095 (1962)**

## Solar Plasma Experiment

*Abstract.* A preliminary summary of the data received from the Mariner II solar plasma experiment for the period 29 August through 31 October 1962 is presented. During this period there was always a measurable flow of plasma from the direction of the sun. The velocity of this ion motion was generally in the range 400 to 700 km/sec. Time variations, plasma density, and ion temperatures are also discussed.



Indisputable evidence of the existence of the predicted supersonic flow, i.e., the **“SOLAR WIND”**



Start of a new era of heliospheric research



# We are PARKER SOLAR PROBE!

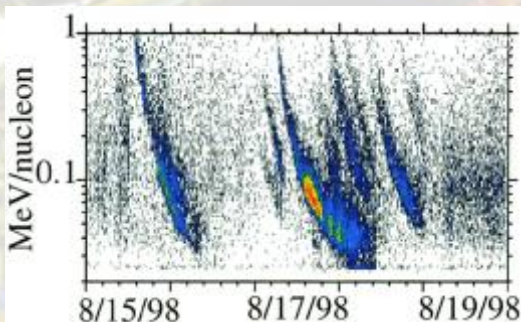
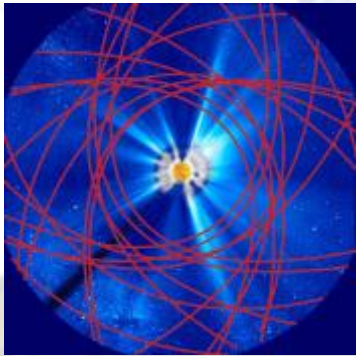
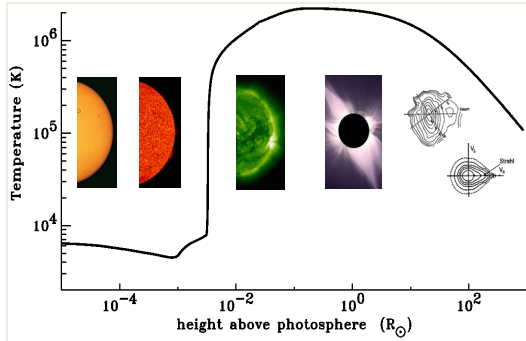


## Parker, meet Parker





# Parker Solar Probe Science



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

# Launch and Mission Design Overview



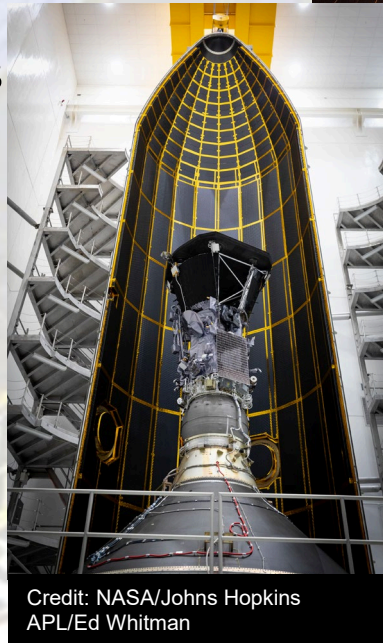
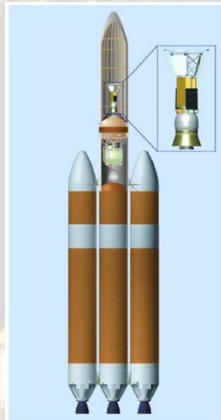
## Launch

- Aug 12, 2018 at 3:31 a.m. EDT (7:31 UTC)
- Max. Launch C3:  $154 \text{ km}^2/\text{s}^2$
- Delta IV-Heavy with Upper Stage
- From NASA's Kennedy Space Center

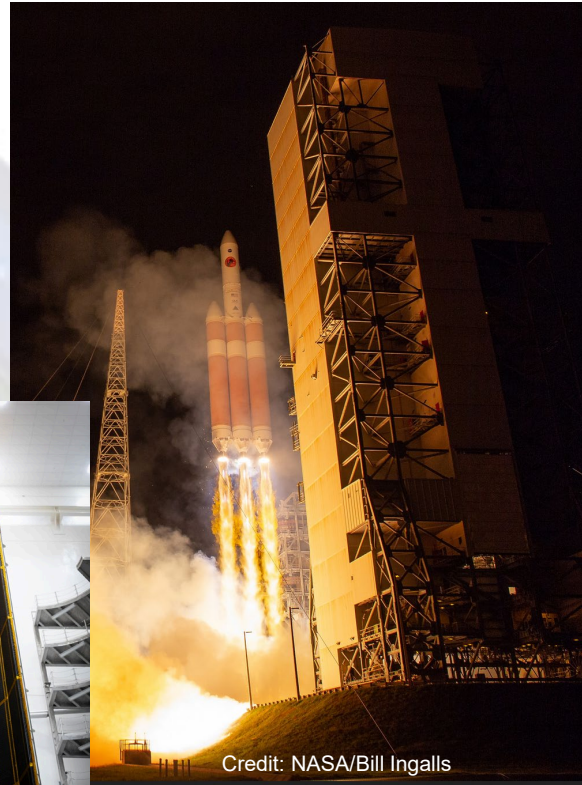
## Trajectory Design

- 24 Orbits
- 7 Venus gravity assist flybys
- Orbit period: 168-88 days

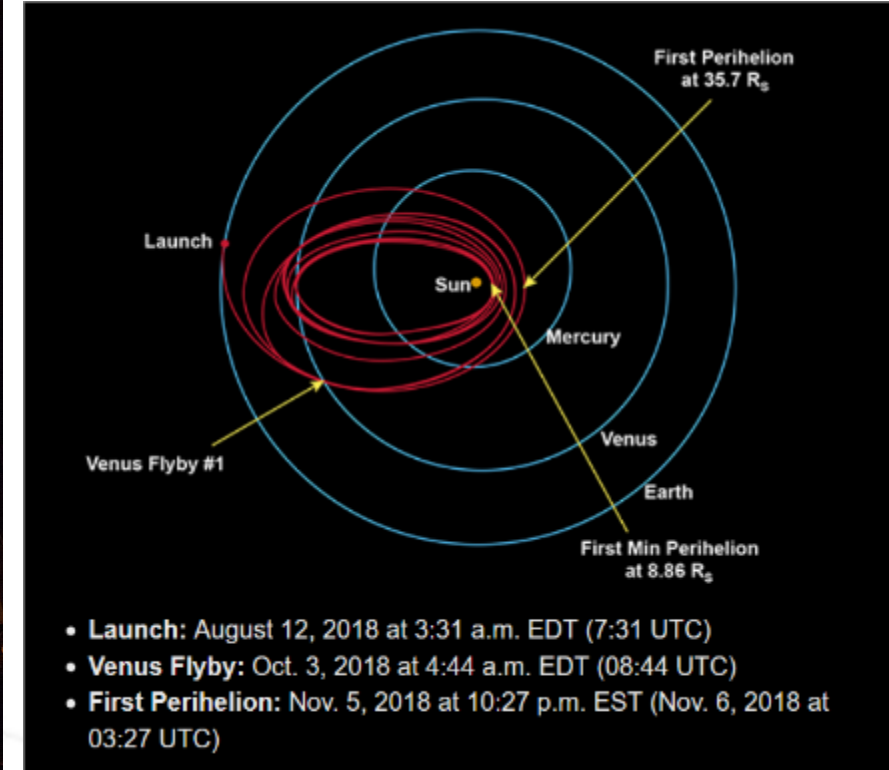
Mission duration: 7 years



Credit: NASA/Johns Hopkins  
APL/Ed Whitman



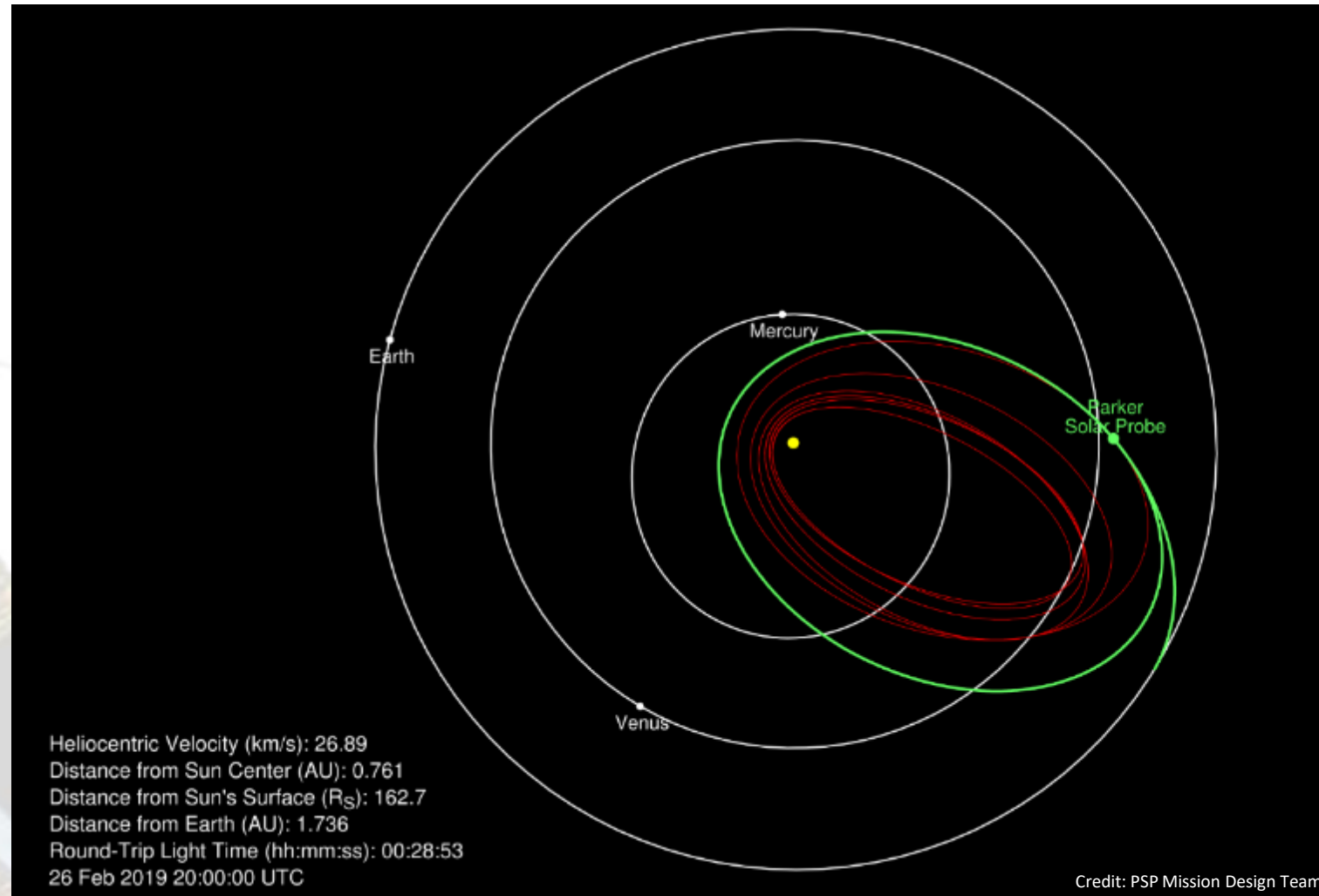
Credit: NASA/Bill Ingalls







# Mission Trajectory and Current Position

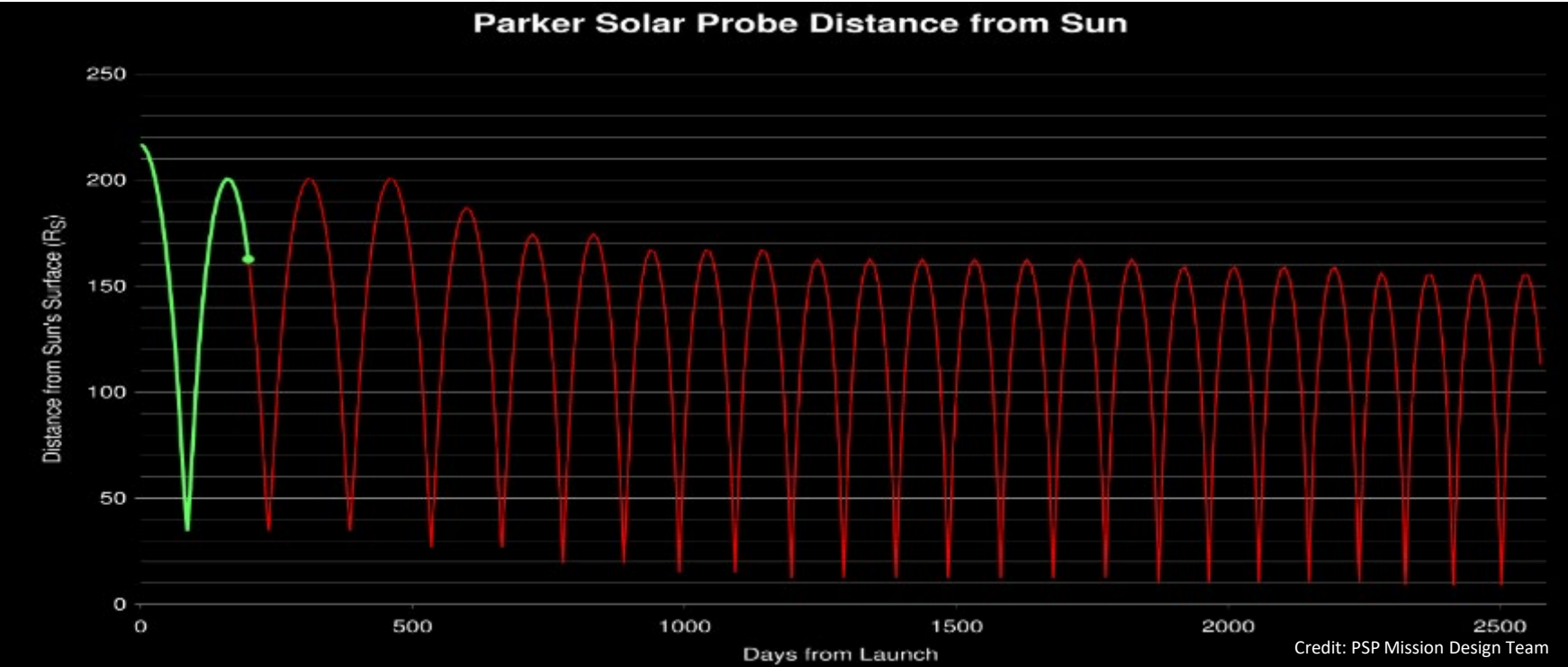


# Mission Design

## Solar Orbits and Solar Distances



Orbit #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Period (d)	168	150	150	140	121	112	107	102	102	100	96	96	96	96	96	96	96	92	92	92	87	88	88	88



- 24 solar orbits, providing abundant opportunities for science investigations in the near Sun region
- Frequent visits of the Sun 3 to 4 times per year
- Perihelion gradually decreased to min solar distance of 0.04587 AU (9.86  $R_S$ )







# PSP is Small and Fast!

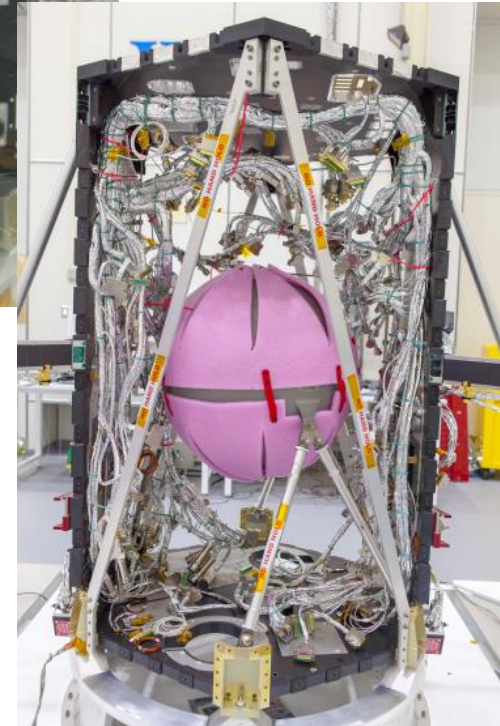


- Parker Solar Probe launched on the most powerful rocket available in 2018 yet needs to be very light and compact to reach the sun



Credit: NASA/Johns Hopkins APL/Ed Whitman

685 kg max launch wet mass  
S/C height: 3 m  
TPS max diameter: 2.3 m  
S/C bus diameter: 1 m  
C-C Thermal protection system  
Hexagonal bus configuration  
Actively cooled solar arrays  
Wheels for attitude control

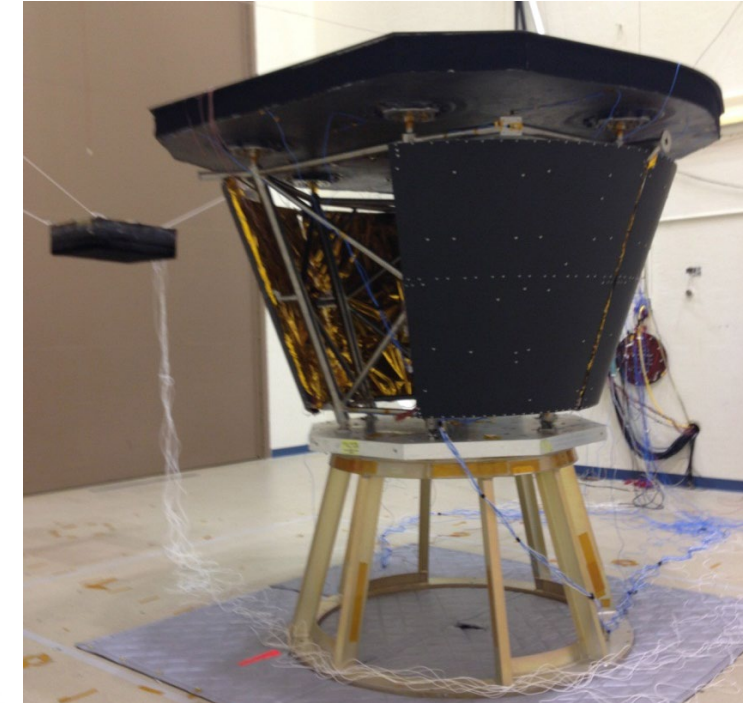




# Thermal Protection System Assembly



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

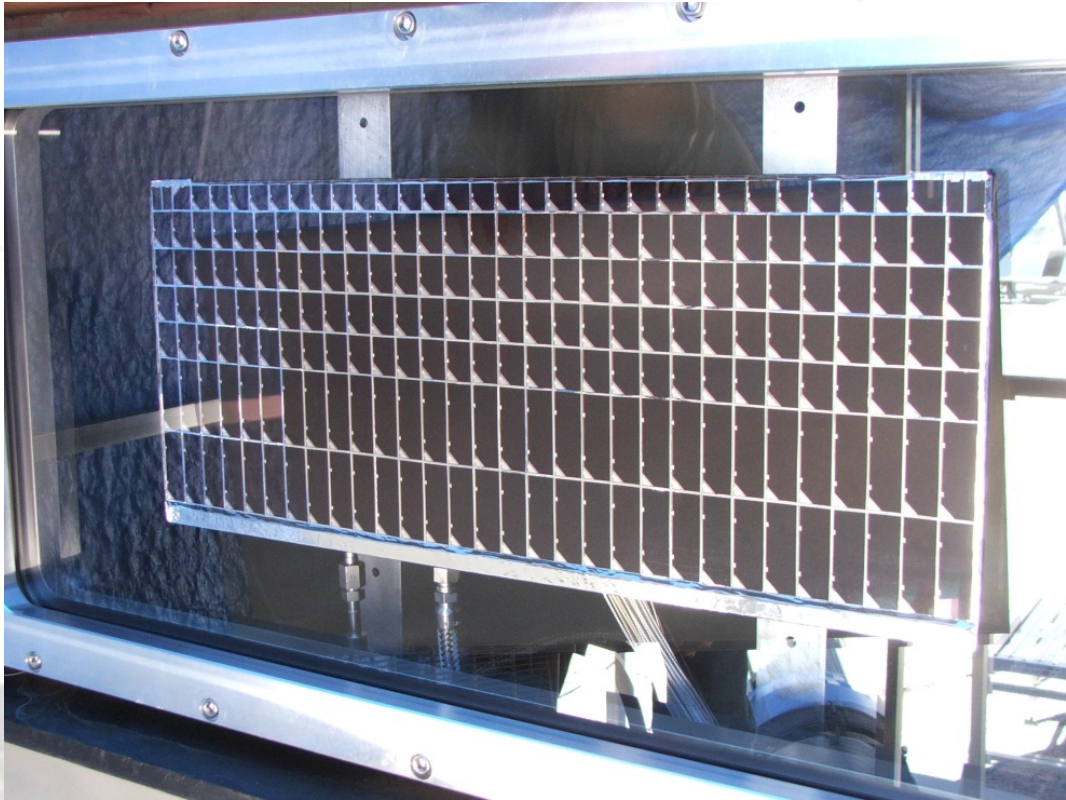




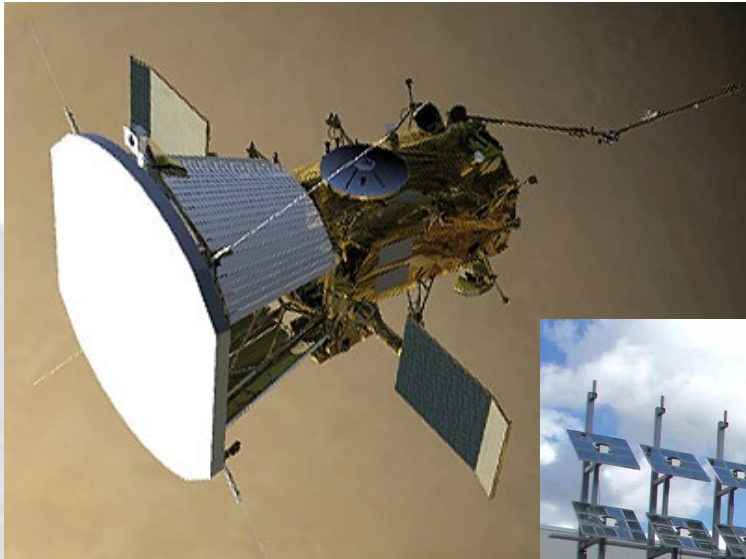
# Solar Array Development



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



Full Sized Solar Array in Heliostat Vacuum Chamber

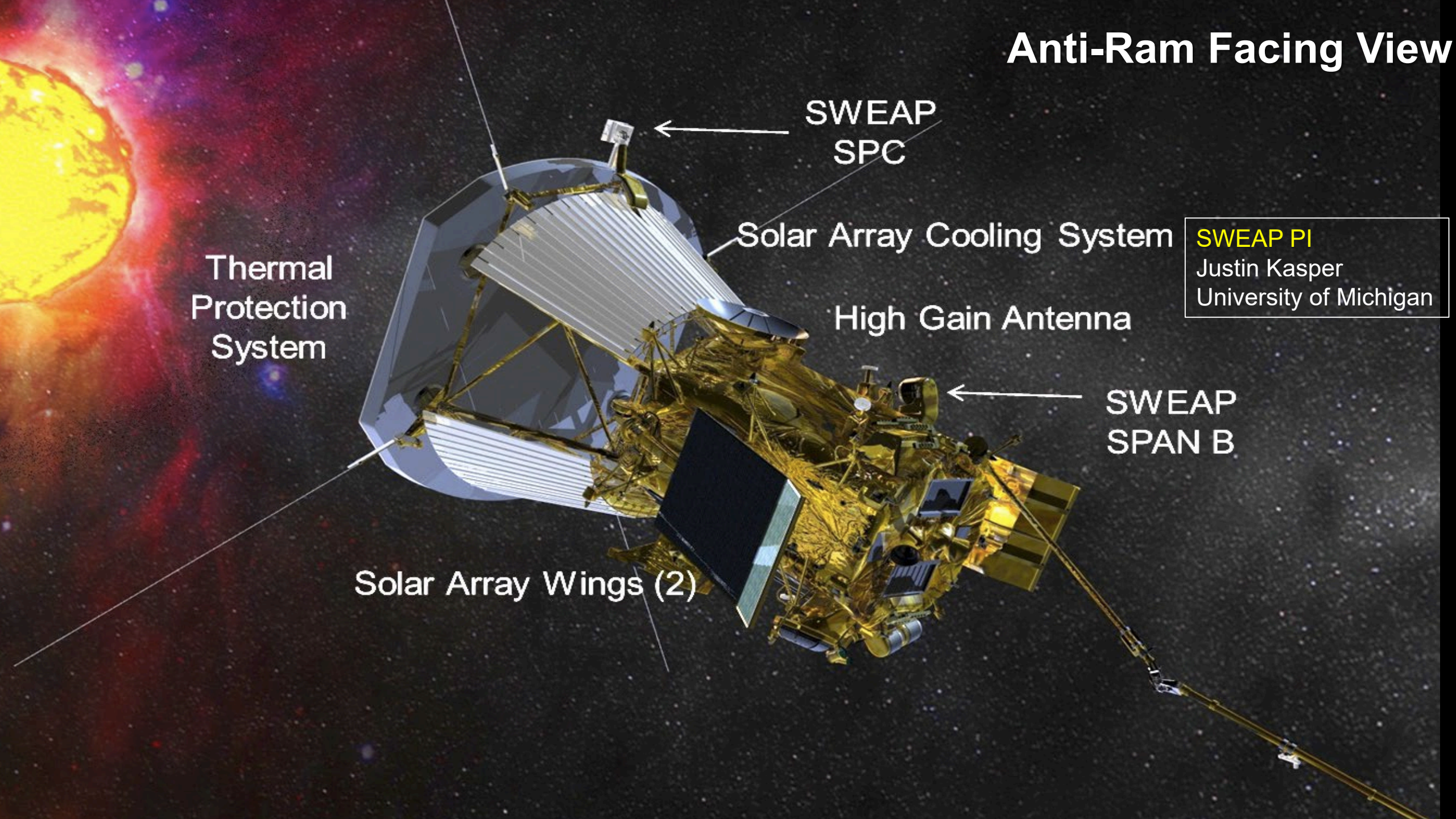


Heliostat





# Anti-Ram Facing View



SWEAP  
SPC

Solar Array Cooling System

High Gain Antenna

SWEAP  
SPAN B

Solar Array Wings (2)

Thermal  
Protection  
System

**SWEAP PI**  
Justin Kasper  
University of Michigan



# Ram Facing View

FIELDS Antenna (4)

**FIELDS PI**

Stuart Bale (UC, Berkeley)

**ISOIS PI**

David McComas (Princeton)

**WISPR PI**

Russ Howard  
(Naval Research Lab)

**HelioPSP PI**

Marco Velli (UCLA)

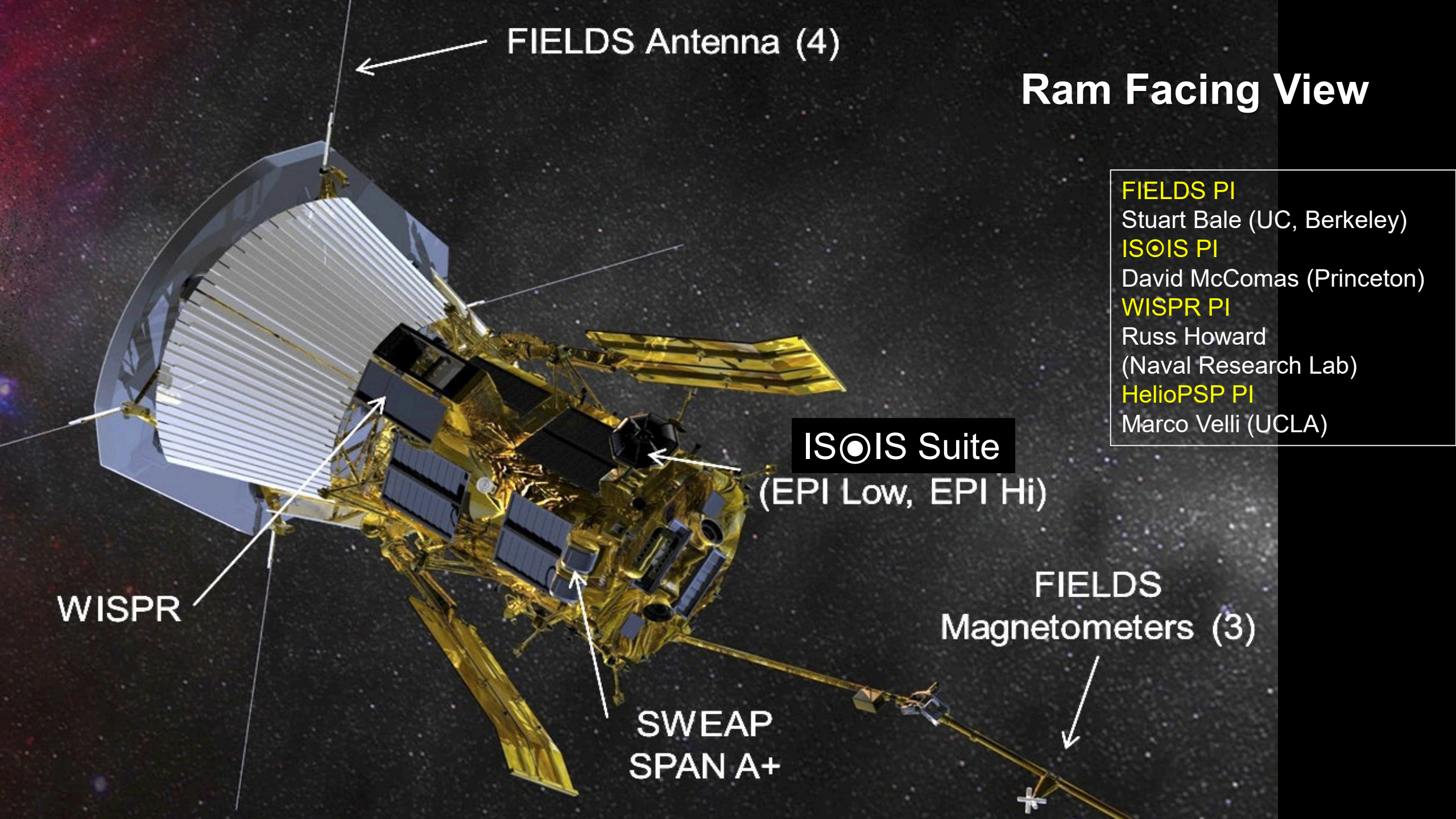
**ISOIS Suite**

(EPI Low, EPI Hi)

WISPR

FIELDS  
Magnetometers (3)

SWEAP  
SPAN A+



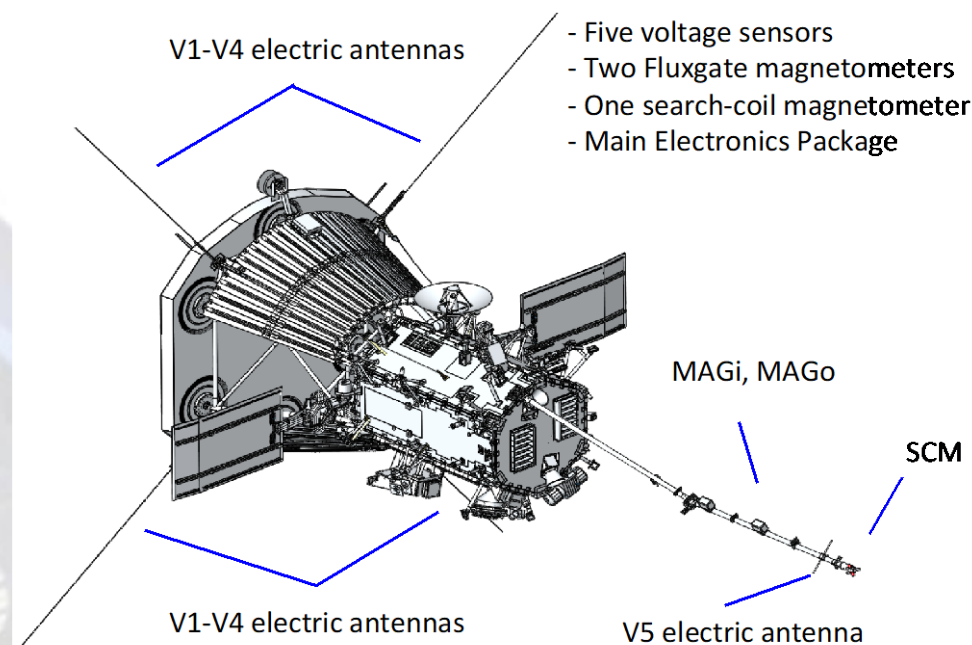
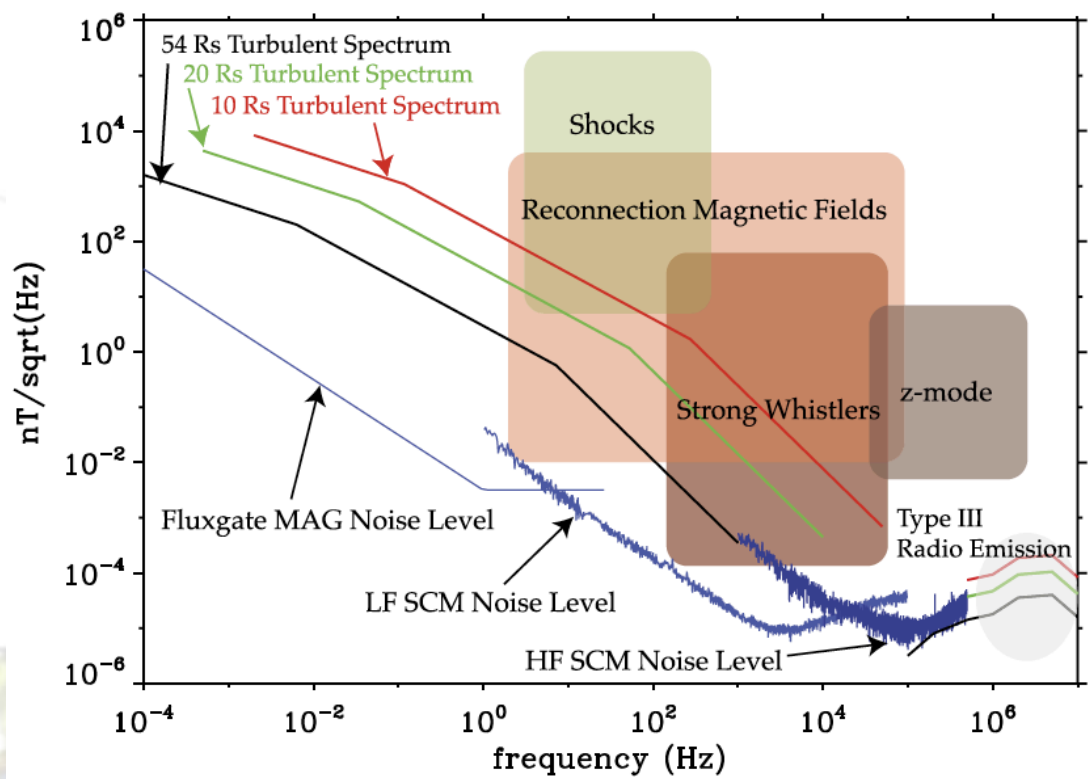


# FIELDS

PI: Stuart Bale (UC 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.

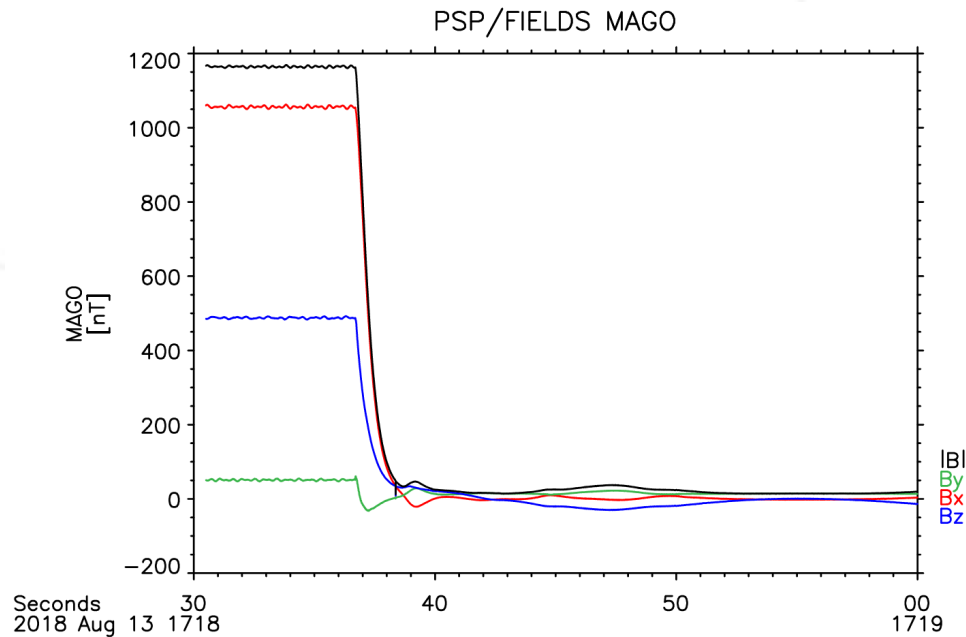


Bale, S. D., et al., "The **FIELDS** Instrument Suite for Solar Probe Plus ...," Space Science Reviews, 204, 49, 2016



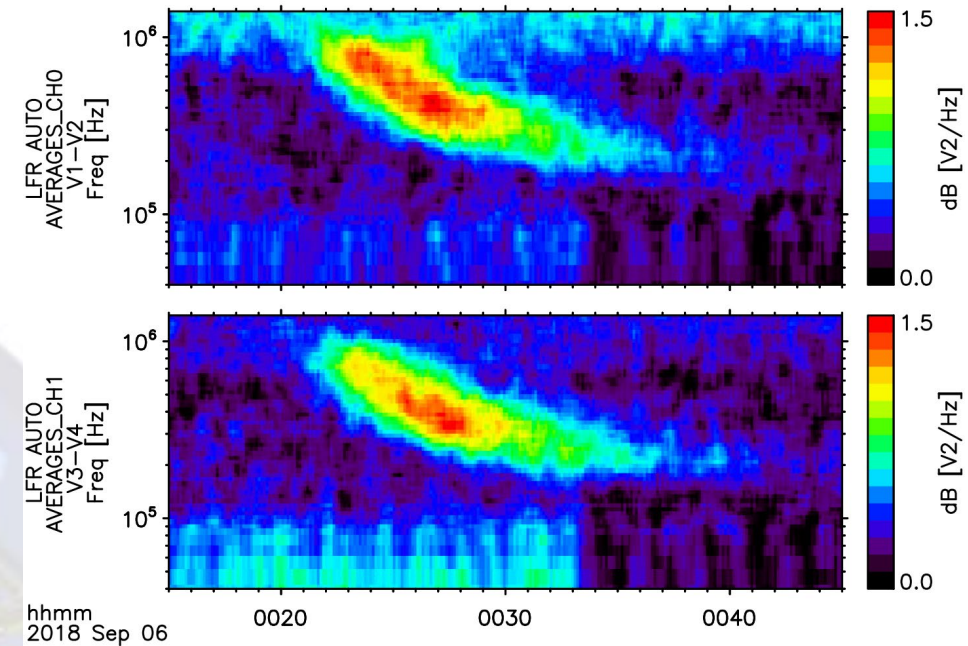
# FIELDS

## Boom Deployment & Type III Burst



Measured magnetic fields as the boom swings away from PSP

First science measurement ever by Parker Solar Probe



First PSP Type-III radio burst from a solar flare

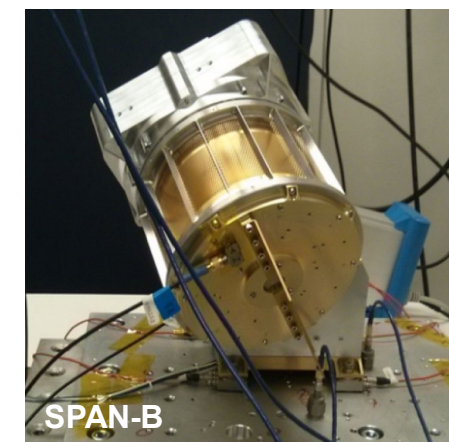
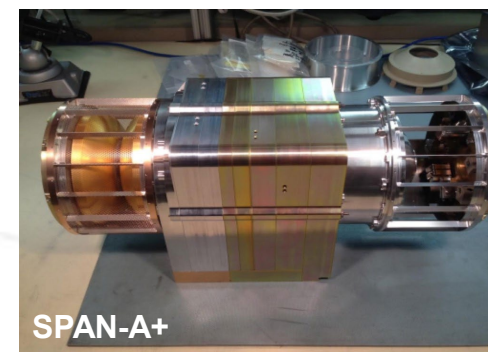
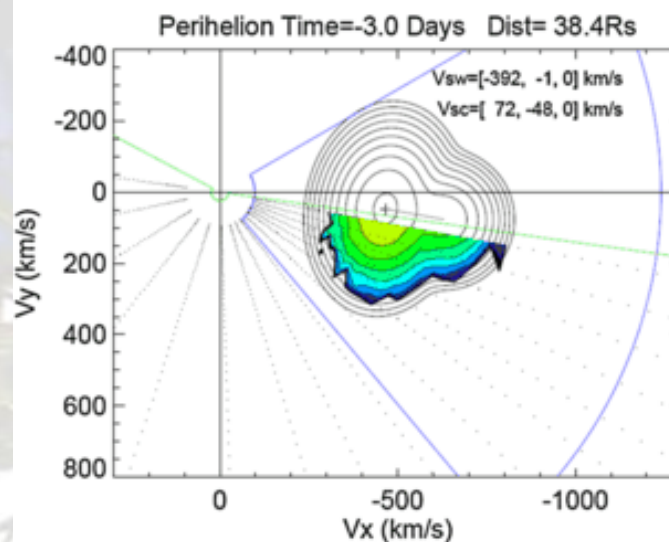
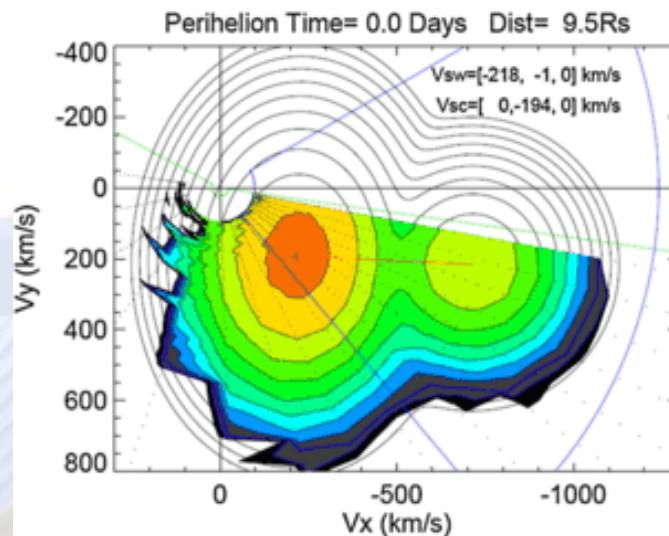
# Solar Wind Electrons Alphas and Protons (SWEAP) Investigation

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





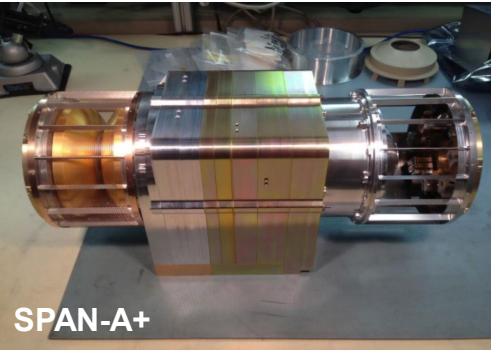
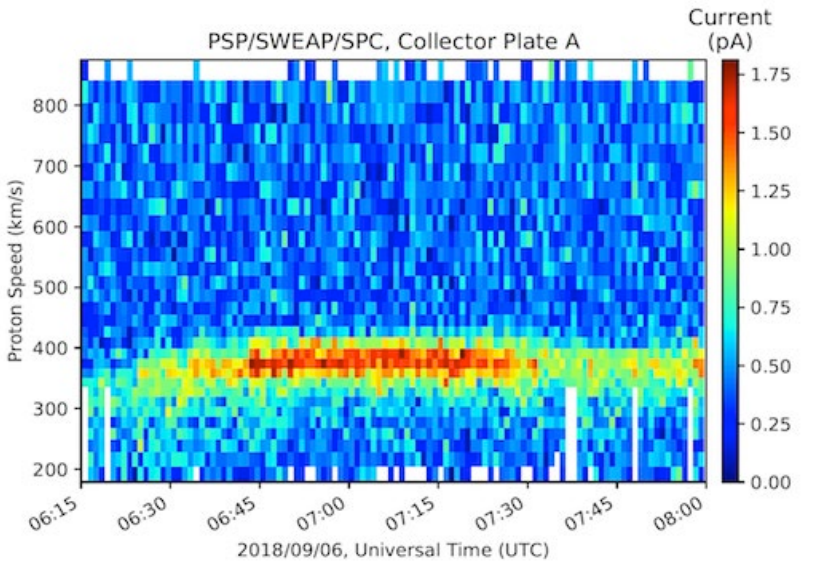
# SWEAP

## Unexpected Signature of the Slow Solar Wind

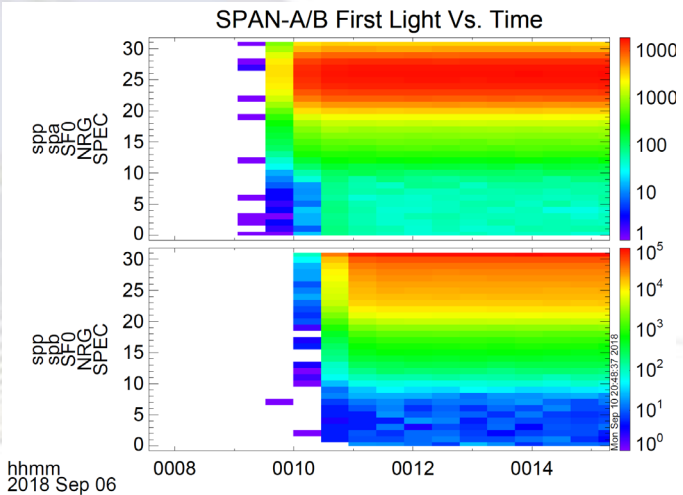
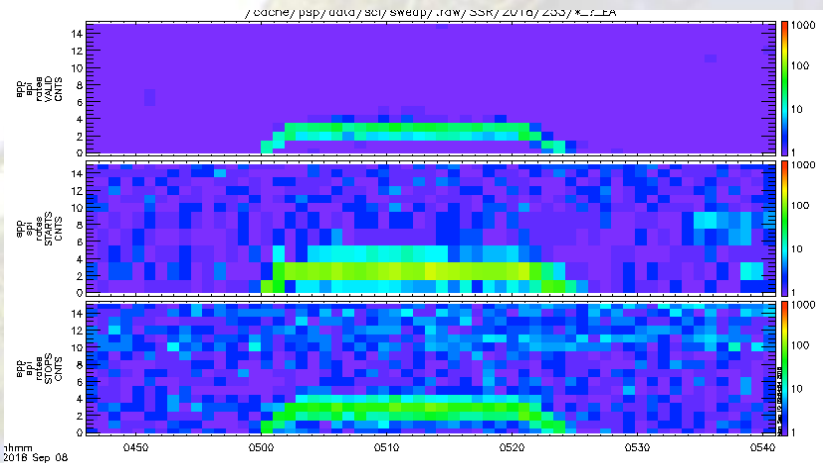


SWEAP Solar wind measurements (slew)

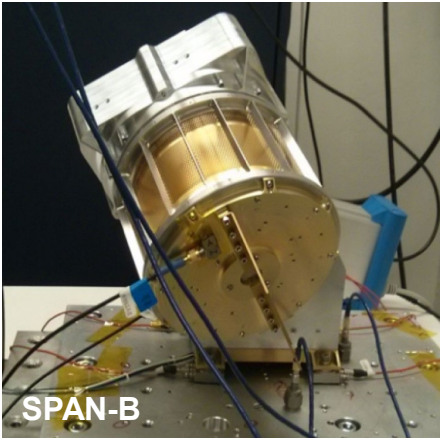
SPC



SPAN-Ai



Electron  
SPAN-A/B

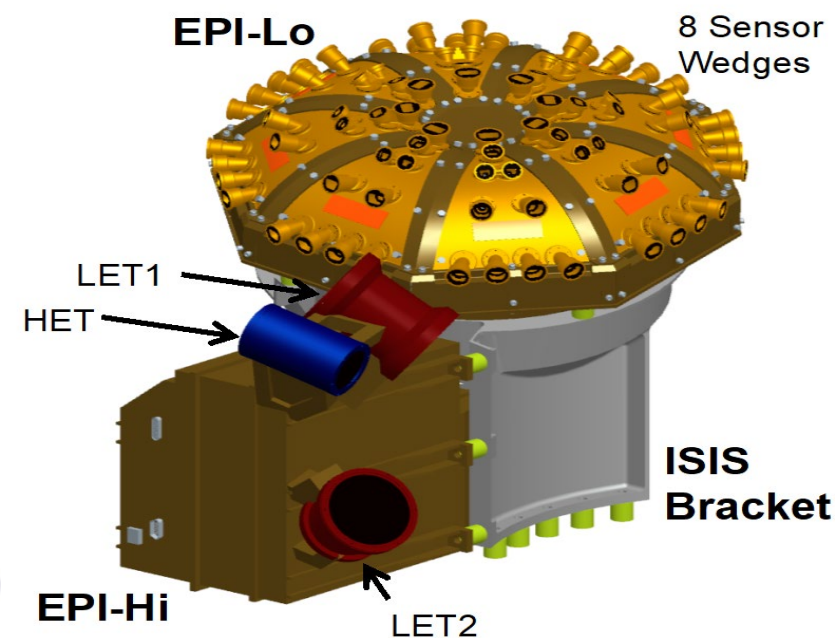
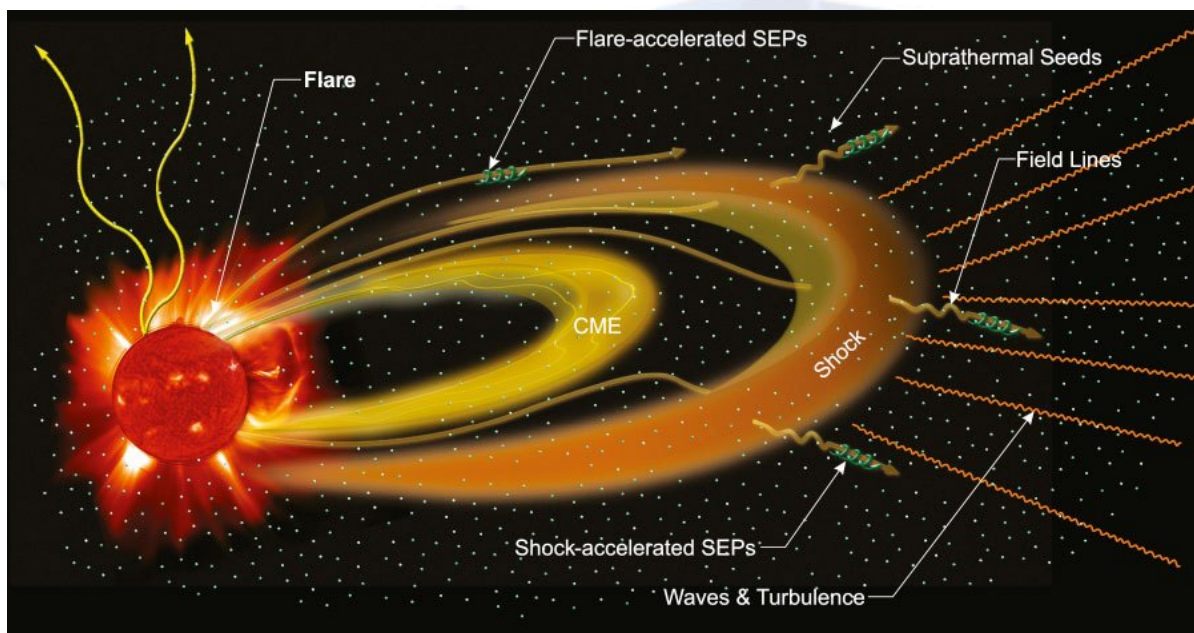


# Integrated Science Investigation of the Sun (IS $\odot$ IS)

PI: David McComas (Princeton University)



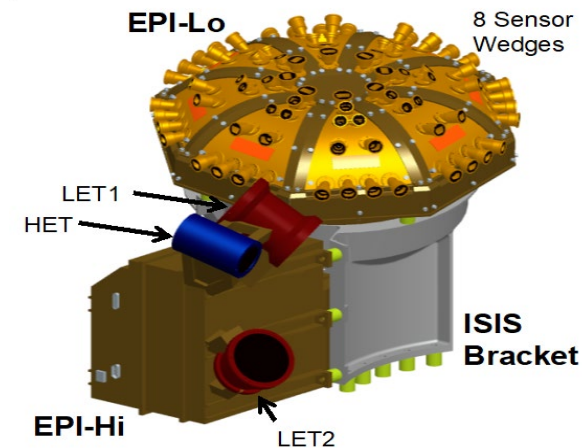
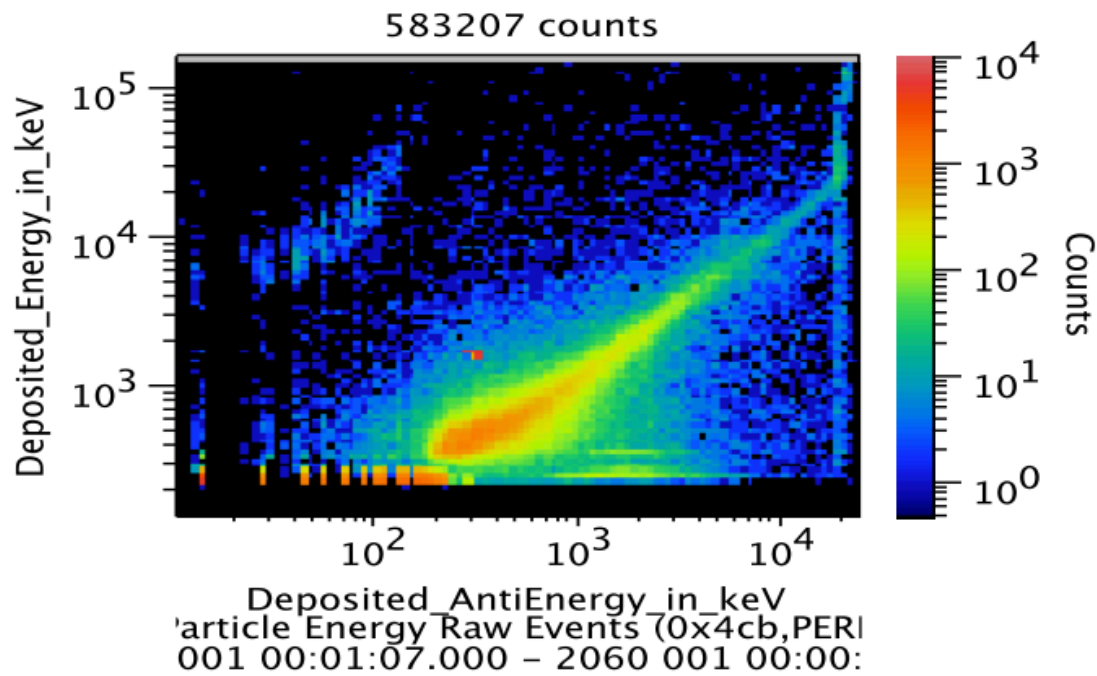
IS $\odot$ IS will measure energetic electrons, protons and heavy ions within the energy range 10s of keV to 100 MeV and correlates them with solar wind and coronal structures.



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

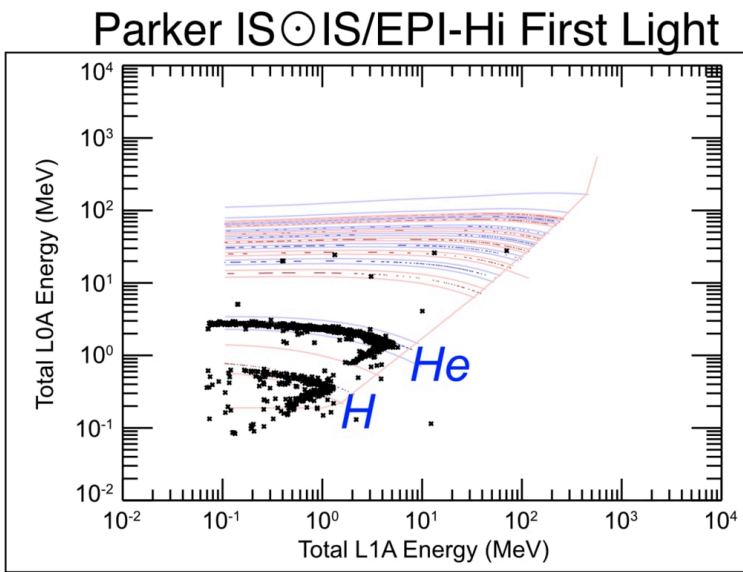


# Integrated Science Investigation of the Sun (IS $\odot$ IS)



**EPI-Lo:** background cosmic rays

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



# Wide-Field Imager for Solar Probe Plus (WISPR)

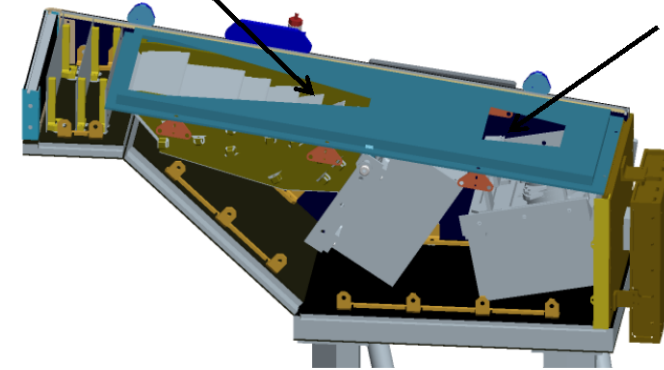
PI: Russ Howard (NRL)



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

Inner Telescope

Outer Telescope



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



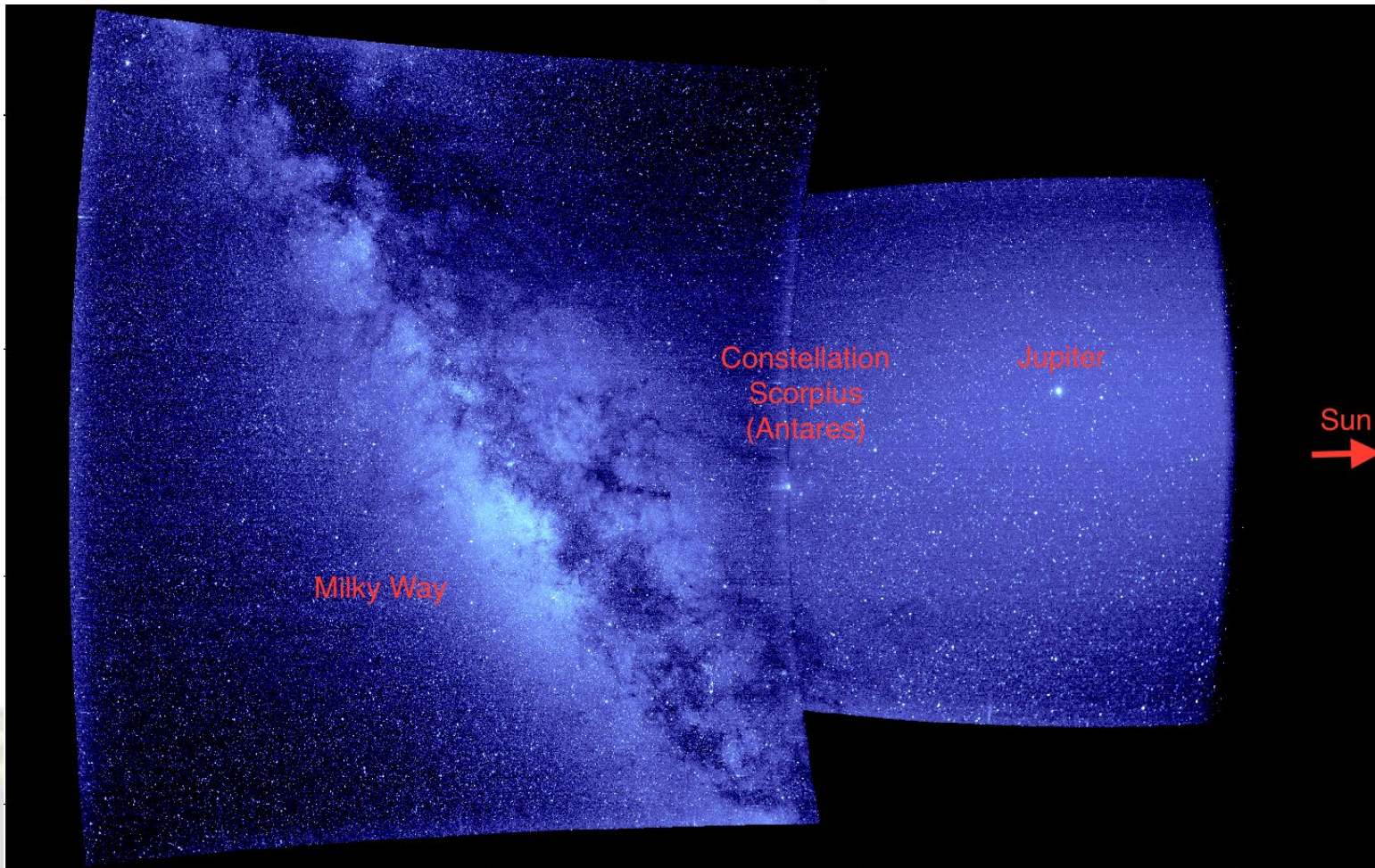


# Wide-Field Imager for Solar Probe Plus (WISPR)

PI: Russ Howard (NRL)

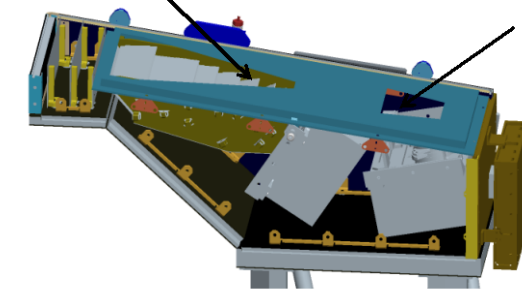


WISPR will image of the solar wind, CMEs, shocks and other structures as they approach and pass the spacecraft.



Inner Telescope

Outer Telescope



**First WISPR images after the door deployment**

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

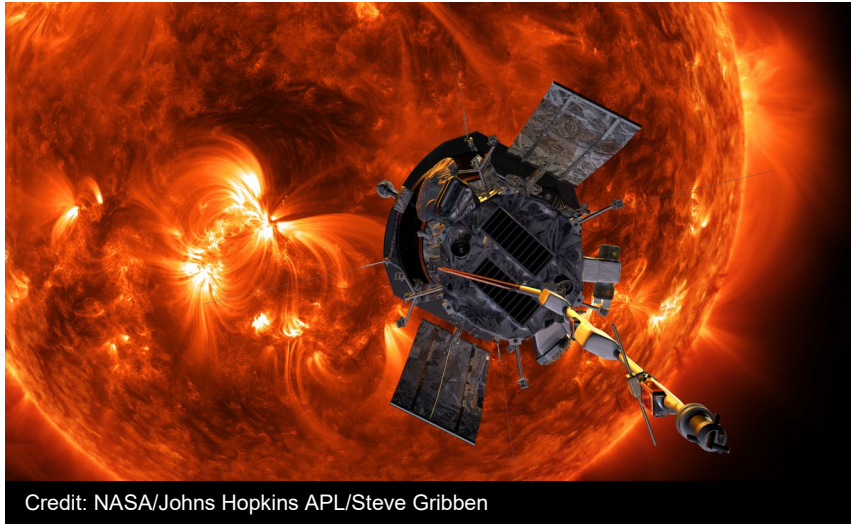
**Outer Telescope:** Milky Way (left)



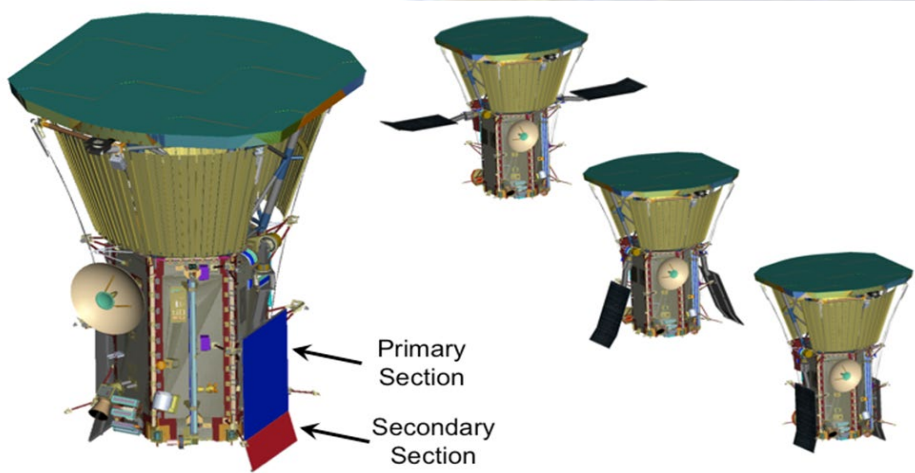
# Parker Solar Probe Looks Back at Home



# Key Mission Characteristics – Unforgiving Environment



- TPS ***must be pointed at the sun*** at most solar distances!
  - Non-TPS components expect near room temperature and will not survive
  - Requirement to restore attitude and wing angle control within **5 seconds** of a processor reset!
- Design Impacts:
  - There is no safe mode without autonomous pointing and power management
  - Extensive on board G&C and autonomy fault handling required
  - Most spacecraft components are redundant
  - Mission is single fault tolerant wherever possible
  - **A flight processor reset is not a failure!**
    - 3 active processors so one can fail and the other two can satisfy attitude control requirement from a processor reset
    - Processor memory must be managed for all processors
- Spacecraft power and heat must be maintained within acceptable limits
  - Autonomous closed-loop solar array control

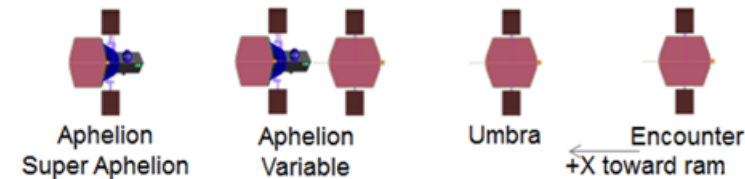




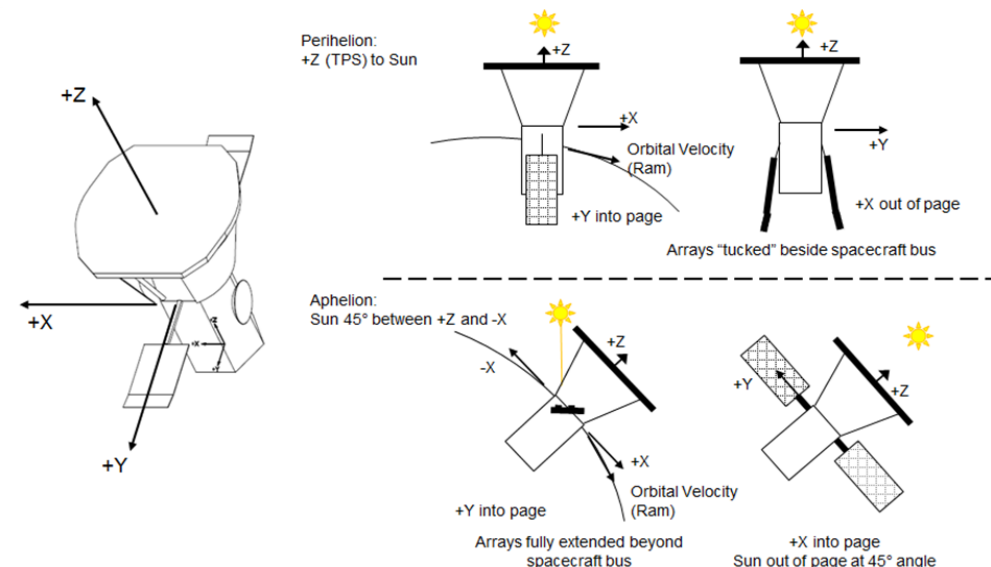
# Key Mission Characteristics – Highly Constrained Spacecraft Attitude



- Attitude changes are infrequent
- No intensive pointing campaigns
- Enables decoupled payload commanding approach
- Attitude constraints result in significant periods of very low uplink and downlink rates
  - Uplink from 7.8125 bps to 2000 bps
  - Downlink rates from 10bps, to 555 kbps
  - Beacon tone (2 bits of health information in 30 minute reception window)
  - Many occurrences of low uplink and high downlink such as (31.25 bps uplink with downlink of 30kbps - 150kbps)
- Downlink constrained by Solar distance and Sun-Spacecraft-Earth angle
- Software developed to take advantage of all Ka band science downlink periods including aggressive rate stepping

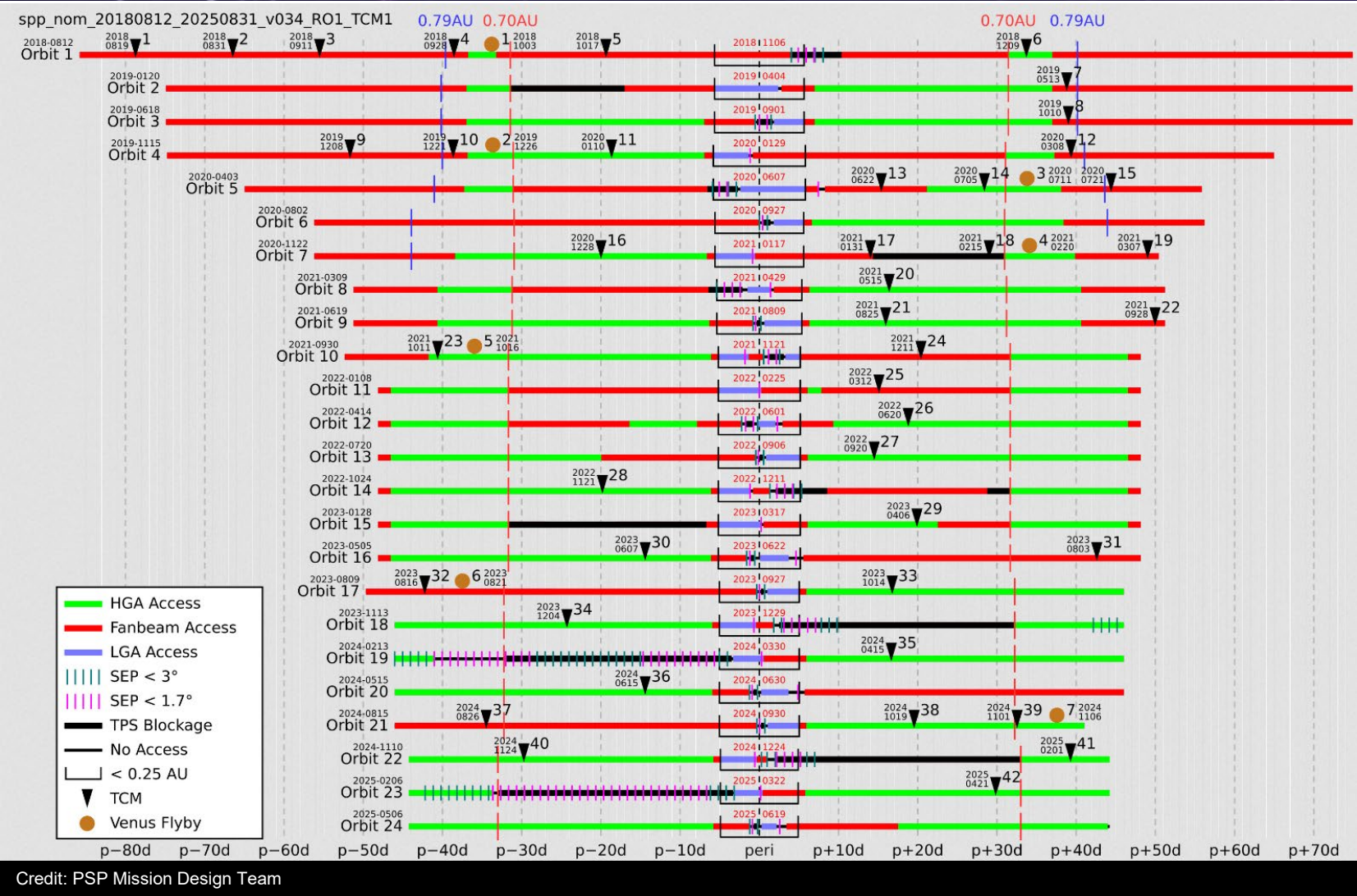


Spacecraft Pointing orientation viewed from sun





# TCMs and Communication Opportunities



# Key Mission Characteristics – Coordinated Decoupled Commanding

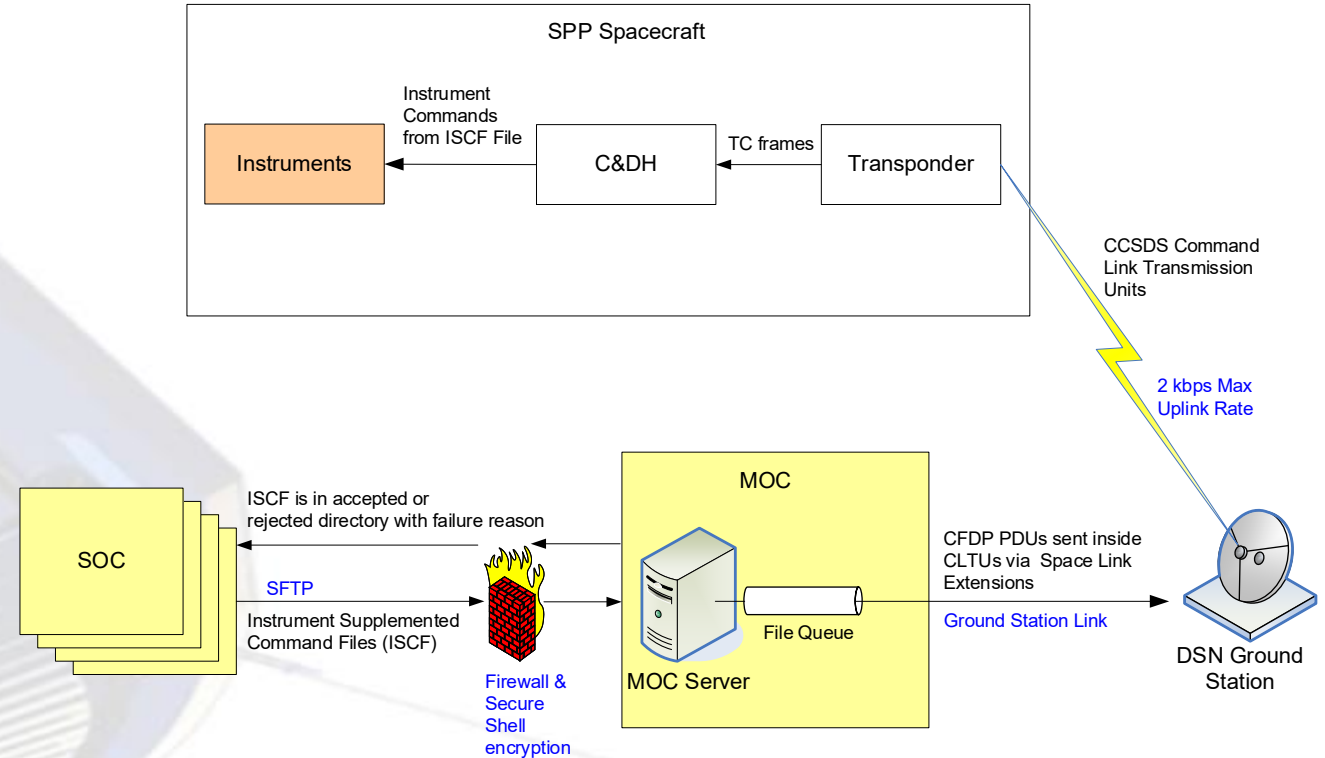


## Decoupled

- SOC's command their own instruments via bent-pipe command file uplink using CFDP
- Instrument commands are not accessible by MOC and not in spacecraft time-tagged sequences
- SOC's monitor their instrument health and status
- Instruments must support recovering from being powered on/off at any time especially during encounter

## Coordinated

- Mission Operations manage instrument power on/off states (insufficient power for instruments and high gain antenna during science downlink)
- MOC and SOC's coordinate uplink periods to ensure timely delivery
- Instrument Command files can be uplinked while the instrument is powered off
- Some instruments have addition SSR and need to choose which data can be downlinked based on quick look.
- Transfer from Instrument SSR to spacecraft SSR must be scheduled and commanded by SOC's

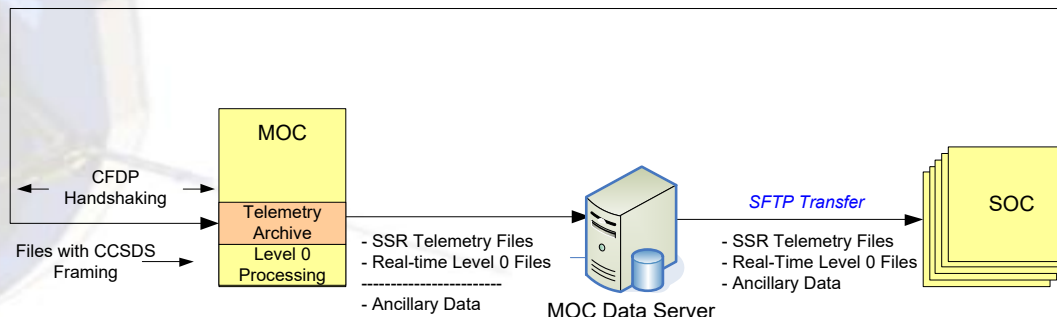
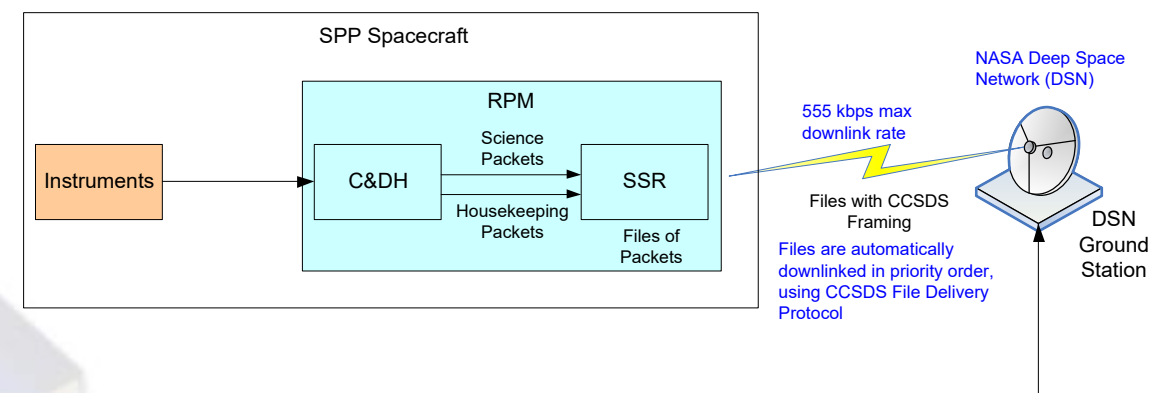




# Key Mission Characteristics – Prioritized CFDP Downlink



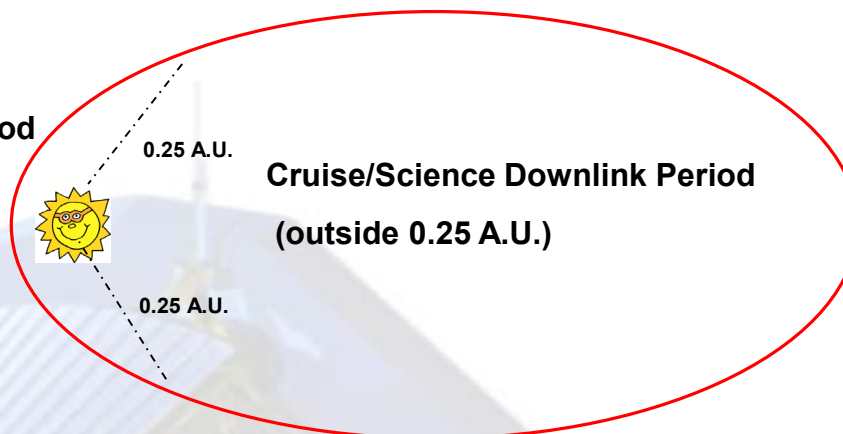
- Mission has 10 priority levels of file recording priorities
- Automated file playback of recorded data in priority order
- Top priorities are spacecraft and instrument health
- SOC's prioritize science data between teams at different priority levels
- Lowest level priority is contingency spacecraft health data that will nominally never be downlinked
- CFDP provides guaranteed complete delivery of files



# CONOPS Overview



**Solar Encounter Period**  
(inside 0.25 A.U.)  
(10-11 Days)



**Cruise/Science Downlink Period**  
(outside 0.25 A.U.)

**24 Solar Encounter Orbits**

Orbital Periods Vary (168 days to 88 days)

## Solar Encounter Period

### Encounter Operations

- Primary science data collection phase – All instruments will be powered on
- Fanbeam/LGA antenna for communications (beacon tones) for monitoring H&S Doppler data to support navigation
- Minimal commanding expected (if any)
- G&C Maintains shade-to-sun attitude (Encounter Attitude)
- No SSR Playbacks

## Cruise/Science Downlink Period

### Science Downlink Operations

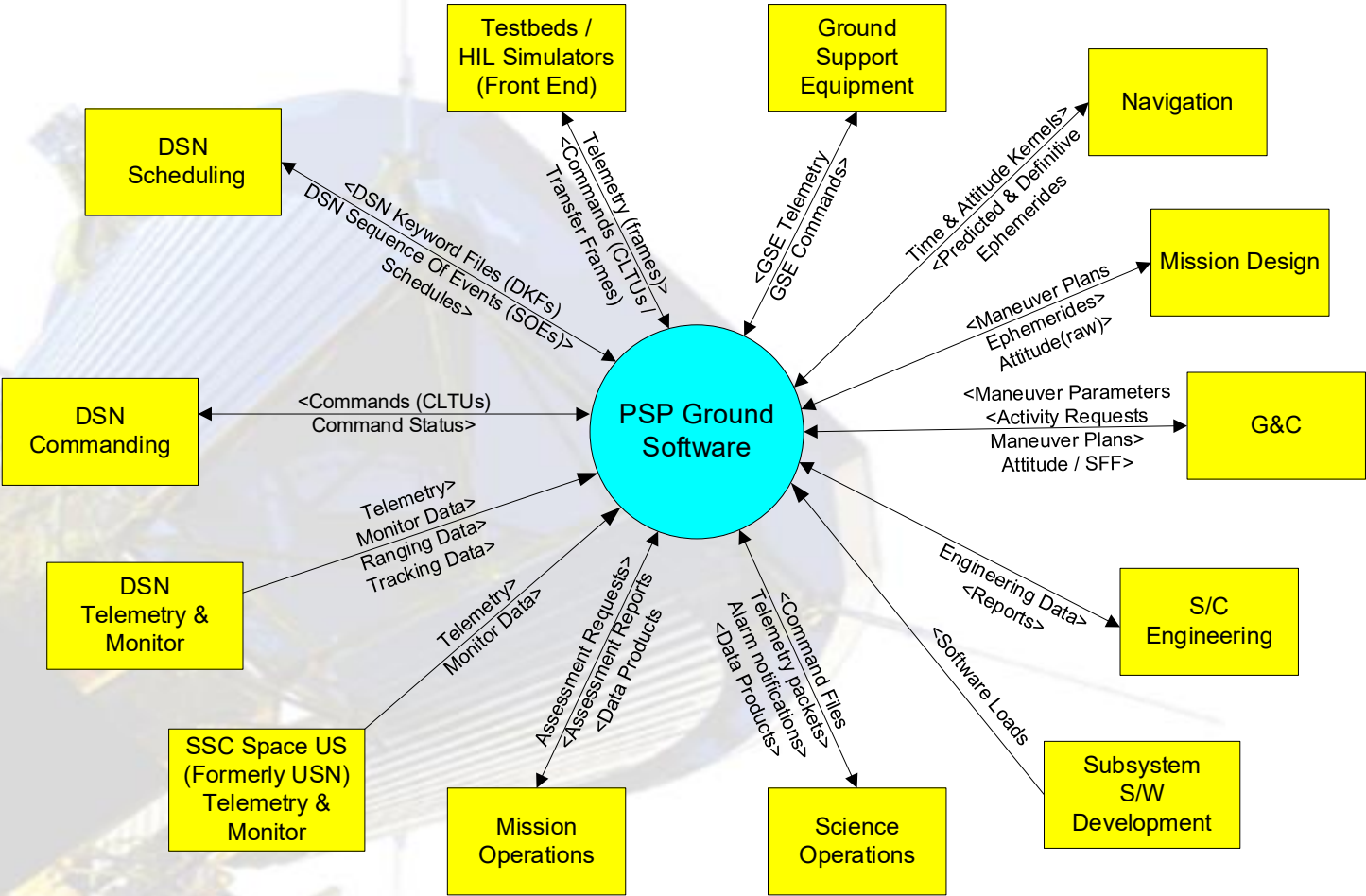
- All instruments powered off
- HGA for communications (Ka-Band, Science & HK data)
- Commanding as needed to support spacecraft maintenance
- Spacecraft Attitude Changes as needed
- SSR Playbacks Supported (High Rate)

### Cruise Operations

- Instruments Can Be Powered On (Sun Distance < 0.82 AU)
  - Instruments off during some activities
- Fanbeam for communications (X-Band, H/K data only)
- Commanding as needed to support spacecraft & instruments
- Spacecraft Attitude Changes as needed
- SSR Playbacks Supported but not ideal (Low Rate)



# PSP Ground Software Context

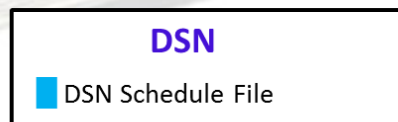
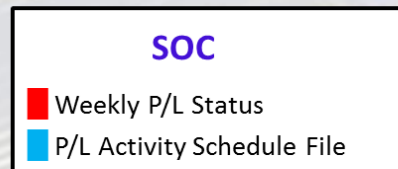
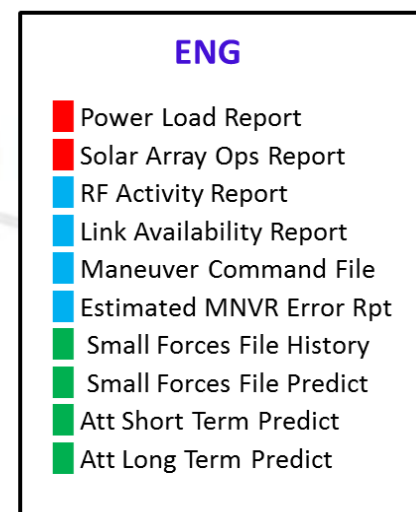
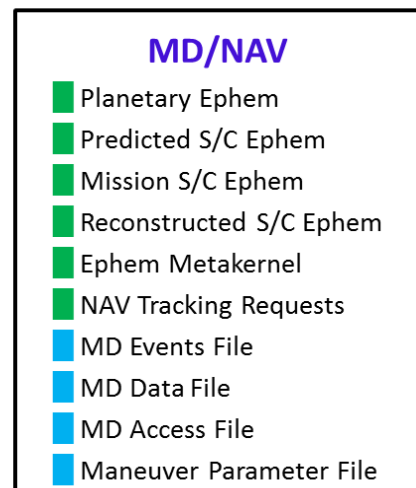
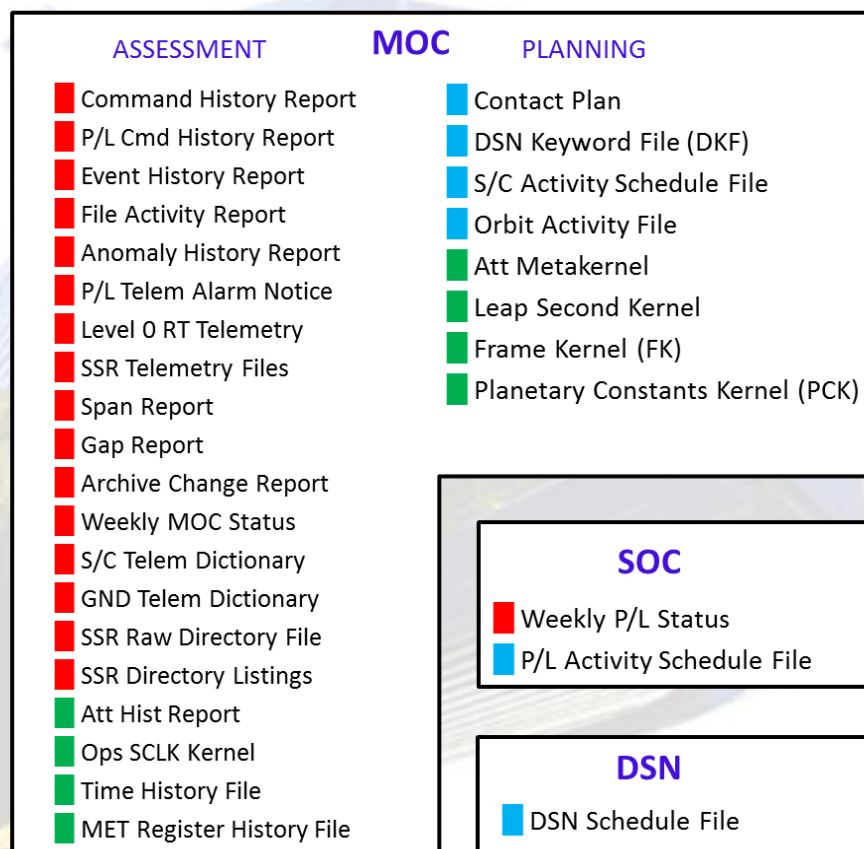


# PSP MOC Data Products




## MOC Data Product Sources

■ flight data   ■ planning data   ■ navigation data

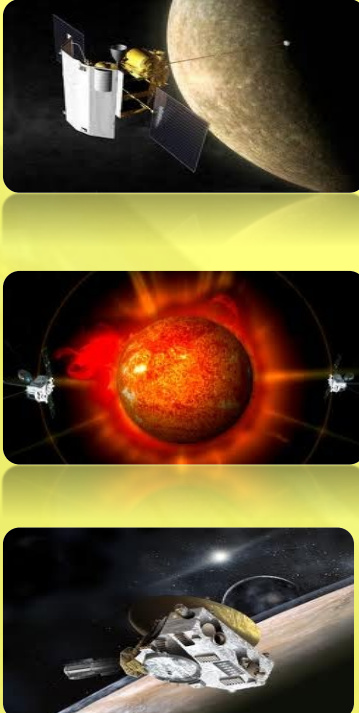





# Ground Software Heritage



1990s  
One-Off Systems

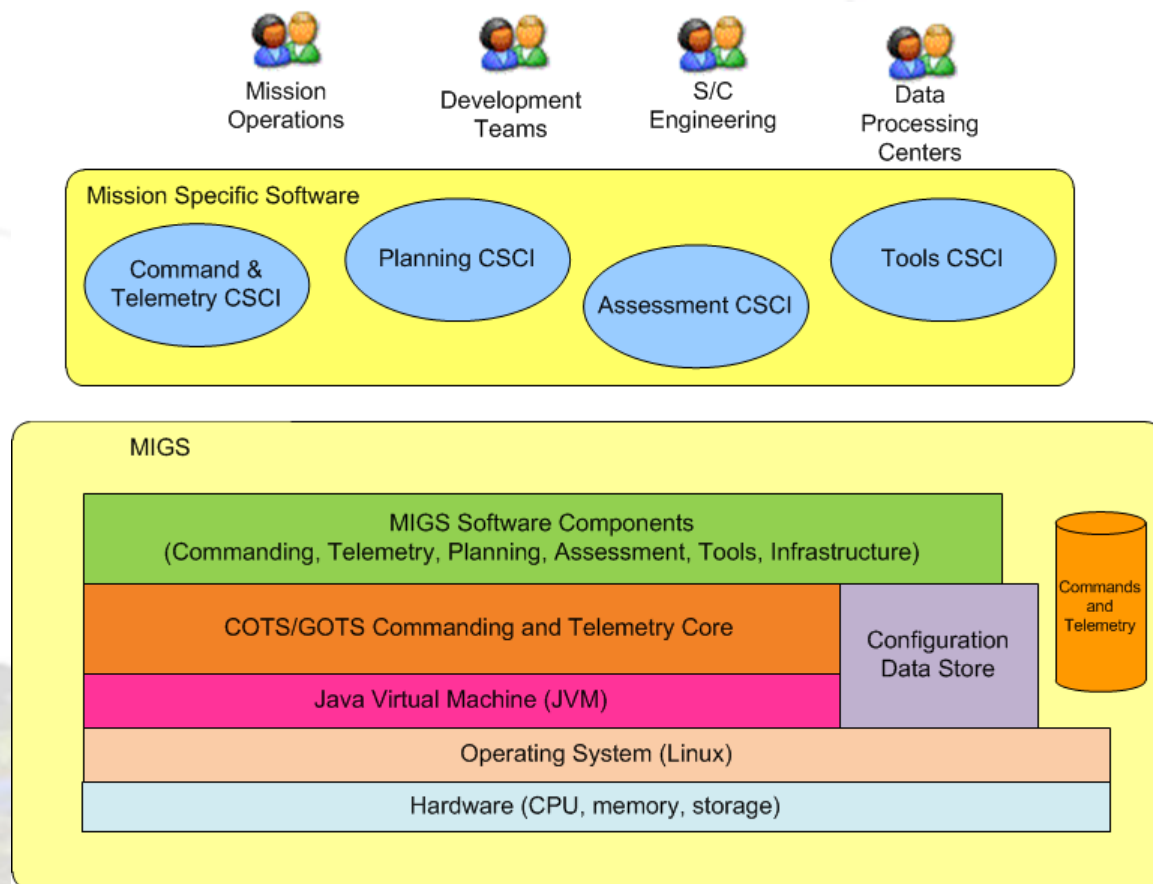


2000s  
Common Ground  
Architecture



2010s  
Mission / System  
Independent  
Architecture

# Mission / System Independent Architecture



- **PSP Ground Software consists of 85 Computer Software Components (CSC)s**
  - Most CSCs are java applications that run in separate JVM processes or application server
  - ~40 CSCs are on-line applications running with an L-3 InControl-NG Commanding and telemetry system
  - Remainder are off-line planning or assessment applications
- **Code is shared across missions and used with mission specific configuration**



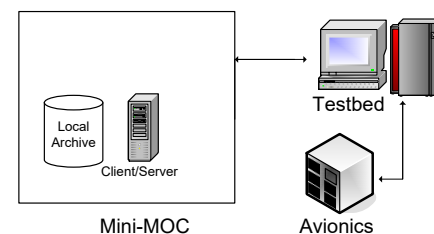
# Ground Software MOC Configurations



The same set of software is used in each configuration

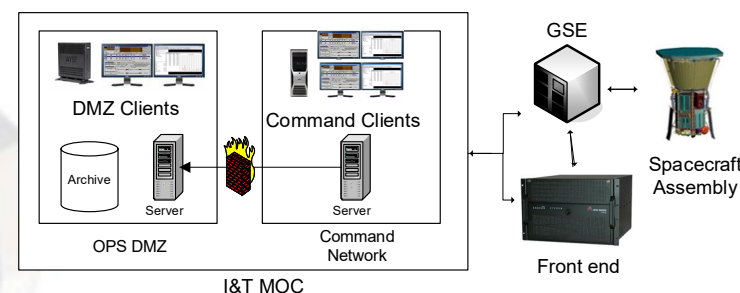
## Mini-MOC / Hardware-In-The-Loop Simulator

- Supports local test of a spacecraft processor subsystem and avionics via a single computer
- Provides primary user interface for the testbed (commanding and telemetry)
- Local archive



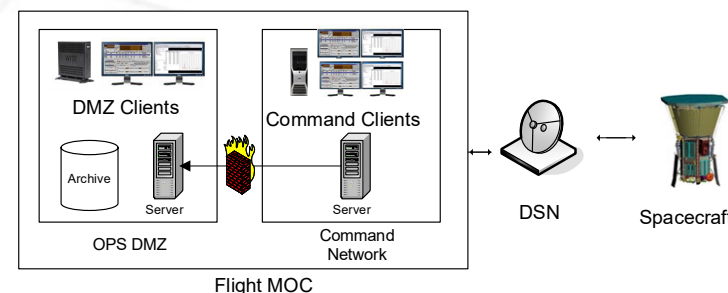
## I&T MOC

- Supports spacecraft I&T, allowing users to send commands to and receive telemetry from the spacecraft under test and GSE
- Central archive in the OPS DMZ
- Other users may view status and telemetry information simultaneously from client workstations connected to controlling I&T MOC workstation and in the OPS DMZ

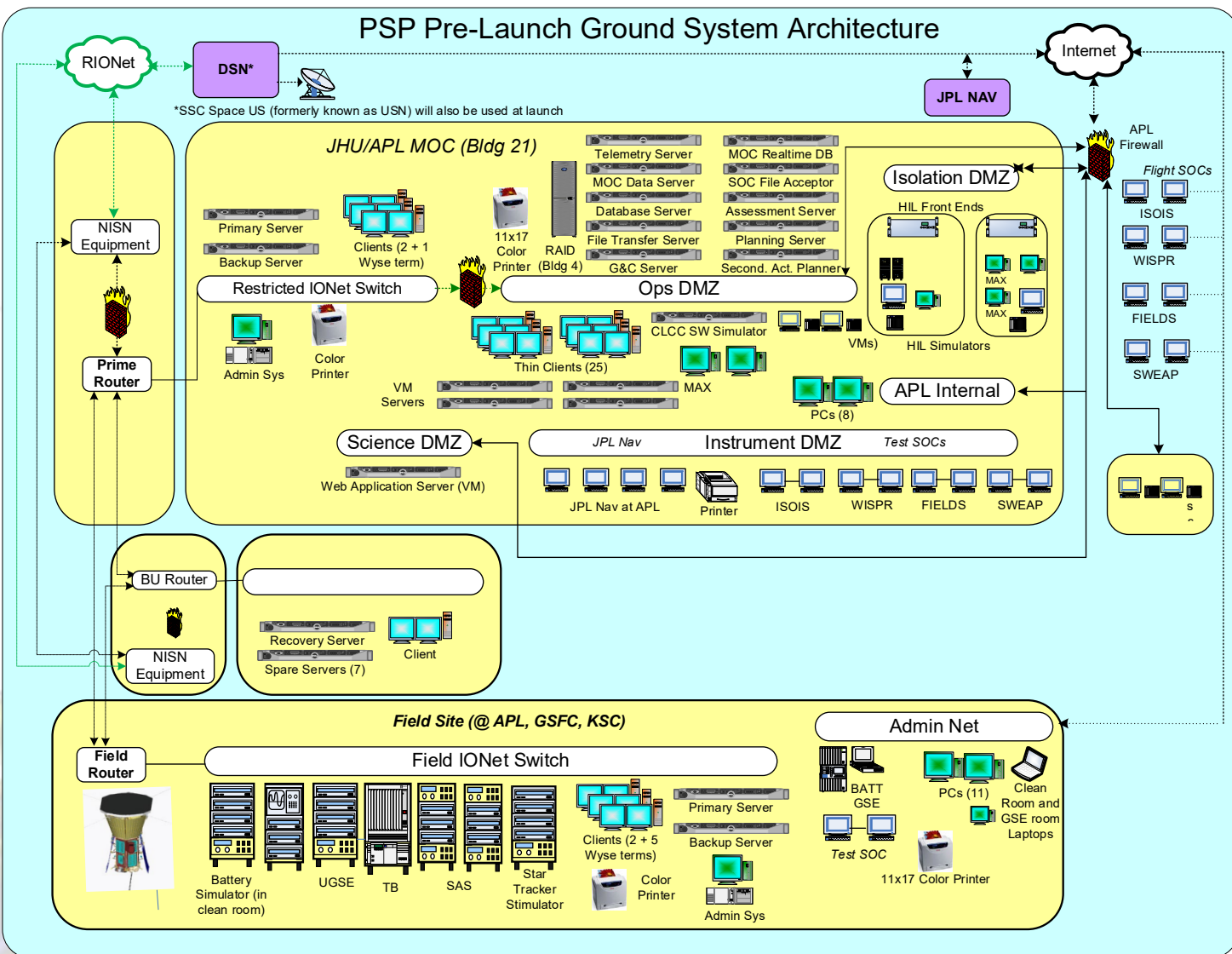


## Flight MOC

- Supports mission simulations, launch and operations, including via ground stations
- Central archive in the OPS DMZ
- Other users may view status and telemetry information simultaneously from client workstations connected to controlling Flight MOC workstation and in the OPS DMZ



# Ground System Architecture



- Most ground software systems run Redhat EL7
- Many systems are Virtual Machine instances
- Systems are automatically backed up and meet NASA IT security requirements
- Spare hardware is ready to recover from any hardware failure
- Mission has a longevity plan that includes replacing computers as they go out of warranty

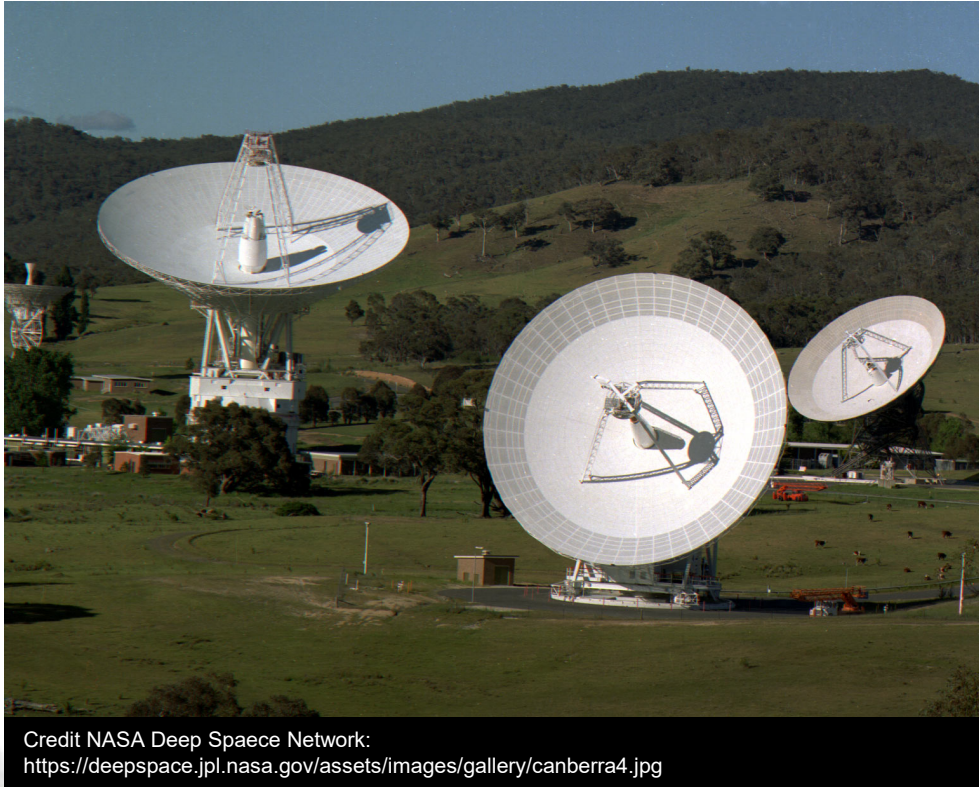
## At peak development:

- 10 Mini-Moc Systems paired with testbeds
- 10 Operational Planning/Assessment Servers
- 25 operational client systems (mostly telemetry viewers)
- 3 OPS Commanding systems
- 2 I&T Commanding systems
- 6 script / page development Mini-Mocs
- 20 ground software development and test systems





# NASA Deep Space Network (DSN) Interfaces



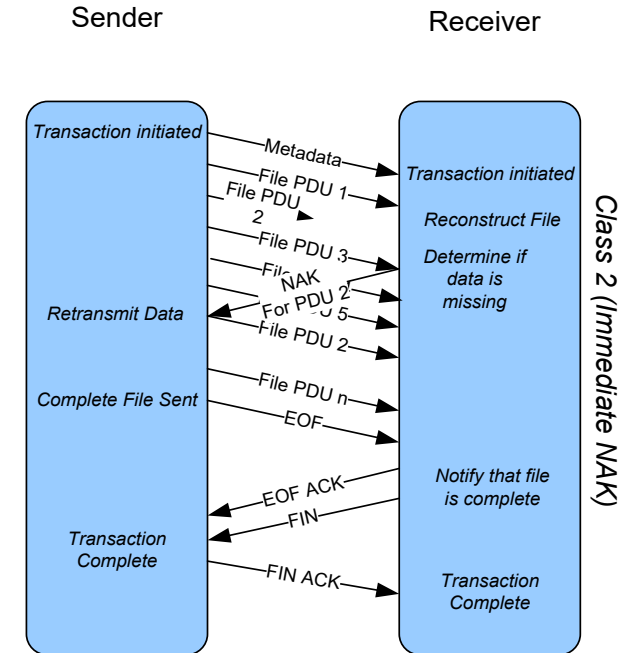
Credit NASA Deep Space Network:  
<https://deepspace.jpl.nasa.gov/assets/images/gallery/canberra4.jpg>

- **PSP is the first of the Mission/Architecture Independent Software Missions to interact with the DSN.**
  - **APL developed gateway to InControl-NG using C++ library from JPL for Commanding, telemetry, and beacon tone**
  - **APL developed DKF, IDR, and Monitor data interfaces**
- **DSN Interfaces**
  - **Space Link Extension Blue Book 2010 CLTU Service**
  - **Space Link Extension Blue Book 2010 RAF Service**
  - **0233-Telecomm Return Beacon Tone Service**
  - **0223-Comm-Web - Internet IDR file delivery of Telemetry Frames**
  - **0158-MON – DSN station monitor data**
  - **DSN Keyword File for station configuration**
  - **DSN schedule retrieval from spsweb**

# CCSDS File Delivery Protocol (CFDP) Uplink



- PSP is the first JHU/APL mission to use CFDP for reliable commanding
- PSP command files contain a series of binary CCSDS TC packets.
- Provides recovery from a dropped command to a deep space spacecraft more efficiently than COP-1 or COP-1 Lite used on previous APL missions
- Enables commanding file delivery to continue across contacts
- Saves uplink bandwidth for command loads going to multiple processors via onboard file copy
- Allows instrument command files to be uplinked while instrument is powered off and later delivered when powered on



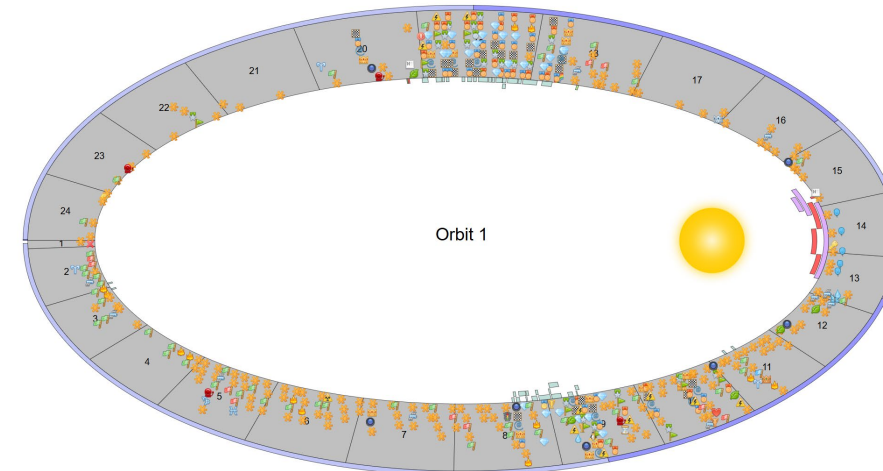


# Activity Planner



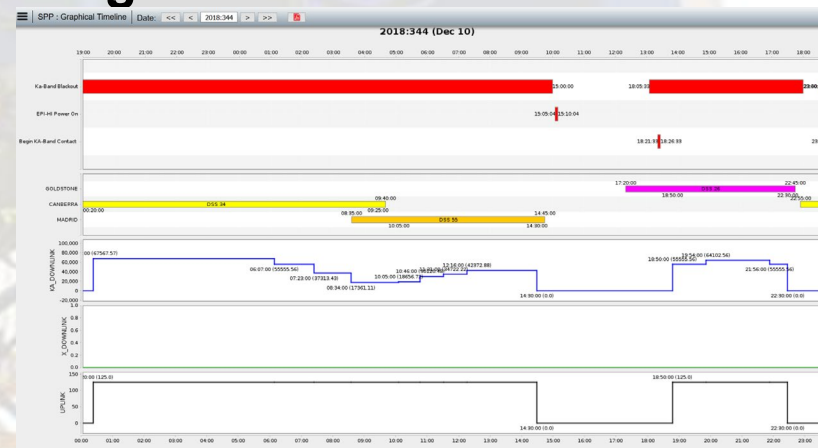
- Modern web application used to plan, schedule, visualize, and communicate spacecraft and ground activities
- Generates spacecraft command loads
- Handles RF configuration and rate stepping activities
- Generates DSN Keyword file to configure DSN ground equipment
- Provides constraint checking between activities

SPP: Ellipse View Orbit: 1 (2018-224 - 2019-020) Go Week: 24 (2019-014 - 2019-020) Go Day: Mon (2019-014) Go 80 0 215



SPP: Contact Planning Date: 2018-344 >>> 3 0 2

Type	GUT	SCIT	GRIT	Activity	Label	State	Comments	Dur	Re-Sync
TT	2018-323 00:00:00			Orbit Segment Start	Orbit Segment Start	O		0:00:15	
TT	2018-344 00:11:37	2018-344 00:25:00		CDH SSR Playback Start	CDH SSR Playback Start	O		0:00:00	
TT	2018-344 08:21:36	2018-344 08:35:00		SOA	SOA	DSS 55	SOA	0:00:00	
GD	2018-344 08:35:00	2018-344 08:45:24		DSN Connections	DSN Connections	DSS 55		0:00:00	
TT	2018-344 09:50:35	2018-344 10:04:00		KA-Band Rate Step	KA-Band Rate Step	O		0:00:00	
TT	2018-344 09:51:35	2018-344 10:05:00		COLD HO IN KA	COLD HO IN KA	DSS 55	Cold Handover Point for Incoming KA-BAND C.	0:00:00	
TT	2018-344 09:51:35	2018-344 10:05:00		BOT (Handover)	BOT (Handover)	DSS 55	BOT for Handover Contact	0:00:00	
TT	2018-344 09:51:35	2018-344 10:05:00		Ka-Band Telemetry Rate Change	Ka-Band Telemetry Rate Change	M	R: Uplink=125.0bps, Downlink=18956.72bps	0:00:00	
TT	2018-344 09:56:35	2018-344 10:10:00		CDH SSR Playback Start	CDH SSR Playback Start	O		0:00:15	
TT	2018-344 10:32:30	2018-344 10:45:00		KA-Band Rate Step	KA-Band Rate Step	O		0:00:00	
TT	2018-344 10:32:30	2018-344 10:45:00		Ka-Band Telemetry Rate Change	Ka-Band Telemetry Rate Change	M	R: Uplink=125.0bps, Downlink=30120.48bps	0:00:00	
RT	2018-344 10:25:00	2018-344 10:38:25	2018-344 10:51:50	CDH CLT Update UTC	CDH CLT Update UTC	DSS 55		0:00:12	
RT	2018-344 10:40:00	2018-344 11:06:50	2018-344 11:06:50	CDH Dump and Clear DST KAband	CDH Dump and Clear DST KAband	DSS 55		0:00:24	
TT	2018-344 11:17:30	2018-344 11:30:55	2018-344 11:30:55	KA-Band Rate Step	KA-Band Rate Step	O		0:00:00	
TT	2018-344 11:17:30	2018-344 11:31:00	2018-344 11:31:00	Ka-Band Telemetry Rate Change	Ka-Band Telemetry Rate Change	M	R: Uplink=125.0bps, Downlink=34722.22bps	0:00:00	
TT	2018-344 12:02:30	2018-344 12:15:55	2018-344 12:15:55	KA-Band Rate Step	KA-Band Rate Step	O		0:00:00	
TT	2018-344 12:02:30	2018-344 12:16:00	2018-344 12:16:00	Ka-Band Telemetry Rate Change	Ka-Band Telemetry Rate Change	M	R: Uplink=125.0bps, Downlink=42372.88bps	0:00:00	
TT	2018-344 14:14:34	2018-344 14:26:00	2018-344 14:26:00	CDH SSR Playback Start	CDH SSR Playback Start	O		0:00:00	
TT	2018-344 14:16:34	2018-344 14:30:00	2018-344 14:30:00	EOT	EOT	DSS 55	EOT	0:00:00	
RT	2018-344 14:10:00	2018-344 14:23:26	2018-344 14:36:52	CDH NVM HW Write Disable All B.	CDH NVM HW Write Disable All B.	DSS 55		0:00:00	
GD	2018-344 14:18:00	2018-344 14:31:26	2018-344 14:31:26	DSN Disconnect	DSN Disconnect	DSS 55	EDA	0:00:00	
TT	2018-344 14:31:26	2018-344 14:45:00	2018-344 14:45:00	EDA	EDA	DSS 55	EDA	0:00:00	
TT	2018-344 14:43:26	2018-344 14:56:52	2018-344 14:56:52	Terminate Contact	Terminate Contact	O		0:00:25	
TT	2018-344 14:48:26	2018-344 15:01:52	2018-344 15:01:52	GC Command Spacecraft Slew	GC Command Spacecraft Slew	O		0:00:03	
TT	2018-344 15:00:02	2018-344 15:13:28	2018-344 15:13:28	Fields Power On	Fields Power On	O		0:00:05	
TT	2018-344 15:05:04	2018-344 15:18:30	2018-344 15:18:30	EPLHI Power On	EPLHI Power On	O		0:00:05	
TT	2018-344 17:06:34	2018-344 17:20:00	2018-344 17:20:00	SOA	SOA	DSS 26	SOA	0:00:00	
TT	2018-344 17:31:34	2018-344 17:45:00	2018-344 17:45:00	SOA	SOA	DSS 24	SOA	0:00:00	
GD	2018-344 17:33:26	2018-344 17:33:26	2018-344 17:33:26	DSN Connections	DSN Connections	DSS 26		0:00:00	
TT	2018-344 17:55:30	2018-344 18:08:56	2018-344 18:08:56	EPLHI Power Off	EPLHI Power Off	O		0:00:05	
GD	2018-344 17:45:00	2018-344 17:56:26	2018-344 17:56:26	DSN Connections	DSN Connections	DSS 24		0:00:00	
TT	2018-344 18:00:32	2018-344 18:13:58	2018-344 18:13:58	FIELDS Power Off	FIELDS Power Off	O		0:00:21	
TT	2018-344 18:02:00	2018-344 18:15:26	2018-344 18:15:26	GC Command Spacecraft Slew	GC Command Spacecraft Slew	O		0:00:03	
TT	2018-344 18:16:33	2018-344 18:30:00	2018-344 18:30:00	BOT (Backup)	BOT (Backup)	DSS 24	BOT for Backup Contact	0:00:00	
GD	2018-344 18:05:33	2018-344 18:18:59	2018-344 18:18:59	Ka-Band Blackout	Ka-Band Blackout	R		0:04:27	
TT	2018-344 18:21:33	2018-344 18:35:00	2018-344 18:35:00	Begin KA-Band Contact	Begin KA-Band Contact	O		0:00:00	
GD	2018-344 18:20:00	2018-344 18:33:27	2018-344 18:33:27	TCM Instrument Blackout	TCM Instrument Blackout	R		0:04:00	
TT	2018-344 18:36:33	2018-344 18:50:00	2018-344 18:50:00	BOT	BOT	DSS 25	BOT	0:00:00	
TT	2018-344 18:36:33	2018-344 18:50:00	2018-344 18:50:00	Ka-Band Telemetry Self-Up	Ka-Band Telemetry Self-Up	M	R: Uplink=125.0bps, Downlink=55555.56bps	0:00:00	
TT	2018-344 18:41:33	2018-344 18:55:00	2018-344 18:55:00	CDH SSR Playback Start	CDH SSR Playback Start	O		0:00:15	
RT	2018-344 19:23:27	2018-344 19:36:54	2018-344 19:36:54	CDH CLT Update UTC	CDH CLT Update UTC	DSS 26		0:00:12	
RT	2018-344 19:25:00	2018-344 19:51:54	2018-344 19:51:54	CDH Dump and Clear DST KAband	CDH Dump and Clear DST KAband	DSS 26		0:00:24	
TT	2018-344 19:40:26	2018-344 19:53:55	2018-344 19:53:55	KA-Band Rate Step	KA-Band Rate Step	O		0:00:00	



JOHNS HOPKINS  
APPLIED PHYSICS LABORATORY

# Command Load Constraint Checker (CLCC)



- CLCC is the faster-than-realtime PSP software spacecraft simulator
- Command loads generated by activity planner are checked by this tool before loading to hardware-in-the-loop simulator and spacecraft
- CLCC uses python models of flight behavior at the lowest fidelity required to verify constraints
- Spacecraft memory configurations are initialized and maintained in CLCC and used a baseline for comparison against hardware simulator and spacecraft

COMMAND LOAD CONSTRAINT CHECKER (CLCC)

Visit the SPP Mission Operations  
SIG Plotted Activity Planner Logout

Simulations

10 entries

Search:

ID	Name	Status	Simulation Start [UTC]	Simulation Stop [UTC]	Run Start [UTC Wall Clock]	Run Stop [UTC Wall Clock]	Actions
1249	19001 Part 3 / 19020	DONE	2019-014 01:00:00	2019-056 08:00:00	2019-014 15:37:10	2019-014 18:23:47	New Details Rerun Rename Delete
1248	19001 Part 3 / 19020	DONE	2019-014 01:00:00	2019-056 08:00:00	2019-011 18:06:18	2019-011 20:54:39	New Details Rerun Rename Delete
1247	19001 Part 3 / 19020	DONE	2019-014 01:00:00	2019-056 08:00:00	2019-010 16:48:43	2019-010 19:34:38	New Details Rerun Rename Delete
1245	19001 part 2 / IV SWEAP test	DONE	2019-011 00:00:00	2019-014 01:00:00	2019-008 16:55:17	2019-008 17:08:39	New Details Rerun Rename Delete
1244	18343 Part 3 / CMDMD 3 / 19001 part 1	DONE	2018-352 18:00:00	2019-011 00:00:00	2019-008 15:25:25	2019-008 16:54:46	New Details Rerun Rename Delete
1243	18343 Part 3 / CMDMD 3 / 19001	DONE	2018-352 18:00:00	2019-020 00:00:00	2018-354 16:51:56	2018-354 18:55:48	New Details Rerun Rename Delete
1235	18343 Part 2 / fields Rotations	DONE	2018-344 01:00:00	2018-352 18:00:00	2018-347 15:14:21	2018-347 15:58:35	New Details Rerun Rename Delete
1234	TCM6C	DONE	2018-342 10:10:01	2018-345 01:00:00	2018-341 14:36:57	2018-341 14:53:39	New Details Rerun Rename Delete
1232	18304 Part 7 / 18343 Part 1 / TCM 6						
1231	18304 Part 6 / load Ephem / SA I-V Sweep						

Showing 1 to 10 of 353 entries

Detailed Simulation View

ID Name Status Simulation Start Simulation Stop Run Start Run Stop

1055 18266 and TCM6C and load 18272 DONE 2018-271 09:00:00 2018-272 16:22:00 2018-272 13:28:04 2018-272 13:35:34

View Parent Details Generate GAO Files Generate Report CSVs

JAS Files(s) Executed:  
dlcc\_dls\_tcm4\_tts.jpg [2018-271 12:35:00]  
spp\_2018\_271\_212000\_02.cpln.jpg [2018-272 07:30:00]  
mo\_spp\_enable\_tcm4c\_tts.jpg [2018-272 12:15:00]  
spp\_2018\_272\_110500\_05.cpln.jpg [2018-272 15:45:00]  
\* Receipt time

Reports  
Display Report:  
Timeline Report

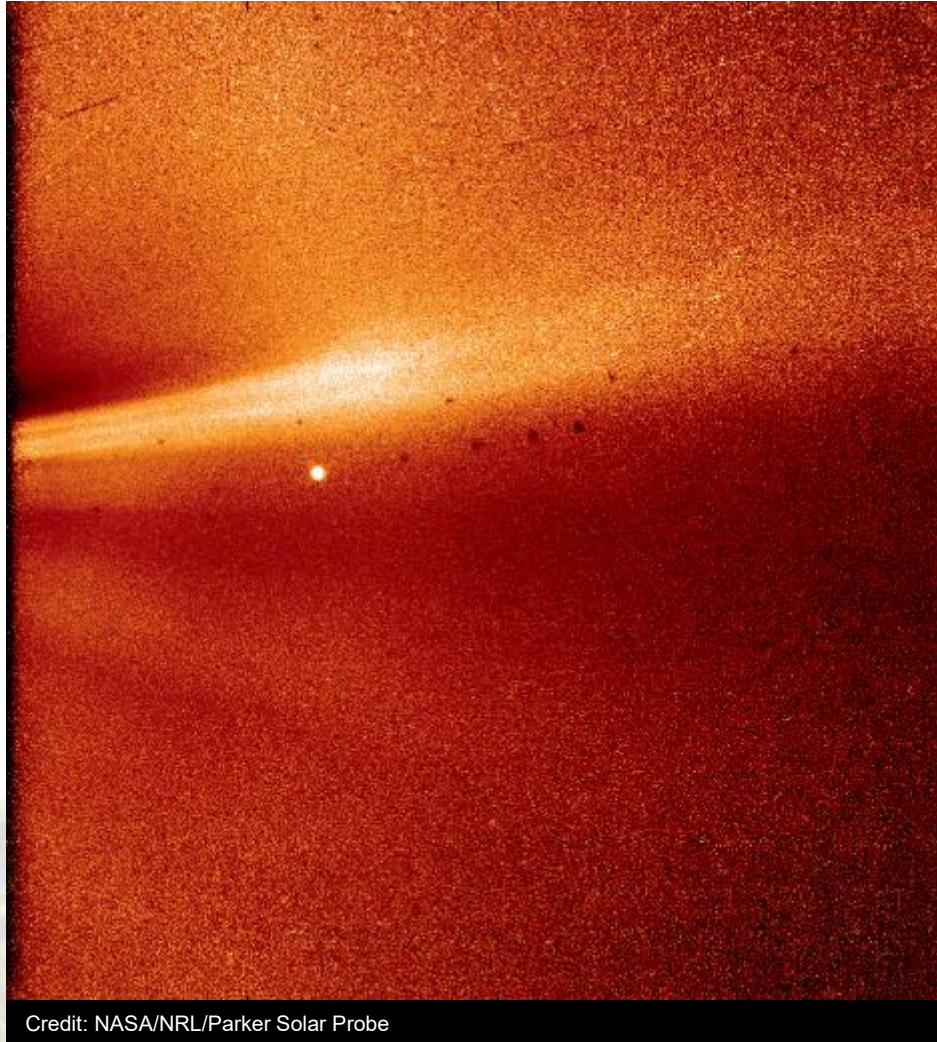
Timeline Report  
Error Warning Info Debug  
Copy Excel CSV PDF Print

Ground Time	Spacecraft Time	MET	TT Bin	Macro Bin	AUT Bin	Priority	Data
2018-271 12:12:37	2018-271 12:10:00	275832603	136			25	FSW_CM.MACRO_EXEC (886)
2018-271 12:12:37	2018-271 12:10:00	275832603	136	886		25	FSW_GCATT_CMD (SUN_POS, EARTH_POS, USER_INPUT, FANBEAM_AXIS, 0.0, 0.0, 0.0, 0.0, 0.0, -0.7071067811865475, 0.0, 0.7071067811865475, -1.0, 0.0, 0.0)
2018-271 12:12:39	2018-271 12:10:02	275832605	136	886		25	FSW_GCATTGUID_PRIMBOOVECTAPHELION_UPLD (RAM, -0.7071067811865475, 0.0, 0.7071067811865475)
2018-271 12:15:01	2018-271 12:12:24	275832747	137			26	FSW_CM.MACRO_EXEC (887)
2018-271 12:15:01	2018-271 12:12:24	275832747	137	887		26	FSW_CM.MACRO_EXEC (716)
2018-271 12:15:01	2018-271 12:12:24	275832747	137	716		26	FSW_TO.TLM_TBL_SEL_FRAME_INTERFACE (6)
2018-271 12:15:01	2018-271 12:12:24	275832747	137	716		26	FSW_TO.TLM_FLUSH_BUFS (FLUSH, FLUSH)
2018-271 12:15:02	2018-271 12:12:25	275832748	137	716		26	FSW_AUT.QUERY_DCB_ID (468, 187, ONE_BYTE, 0)





# Coronal Streamer



Credit: NASA/NRL/Parker Solar Probe

WISPR image of a coronal streamer, seen over the east limb of the Sun Nov. 8, 2018, at 1:12 a.m. EST. Coronal streamers are structures of solar material within the Sun's atmosphere, the corona, that usually overlie regions of increased solar activity.

Parker Solar Probe was about 16.9 million miles from the Sun's surface when this image was taken.

The bright object near the center of the image is Mercury, and the dark spots are a result of background correction.





# PARKER SOLAR PROBE

## BY THE NUMBERS

### 52 DAYS

FASTEST INTERPLANETARY  
VOYAGE (EARTH TO VENUS)

### 213,242 MPH

FASTEST SPACECRAFT

### 15 MILLION MILES

CLOSEST SPACECRAFT  
TO THE SUN

### 1509 MILES

DISTANCE FROM SURFACE  
OF VENUS FOR FIRST FLYBY

### 840°F

ESTIMATED TEMPERATURE OF  
THERMAL PROTECTION SYSTEM  
ON FIRST PERIHELION

### 86 DAYS

FROM LAUNCH TO CLOSEST  
APPROACH TO THE SUN

### 9.5 HOURS

TIME FROM LAUNCH TO  
ORBIT OF THE MOON

### FIRST

MISSION NAMED FOR A LIVING  
PERSON (DR. EUGENE PARKER)

SCIENCE MISSION TO LAUNCH  
ON A DELTA IV HEAVY

WATER COOLED SOLAR  
ARRAY SYSTEM IN SPACE

AUTONOMOUS THERMAL  
MANAGEMENT OF SOLAR  
ARRAYS BY A SPACECRAFT

### 1,137,202

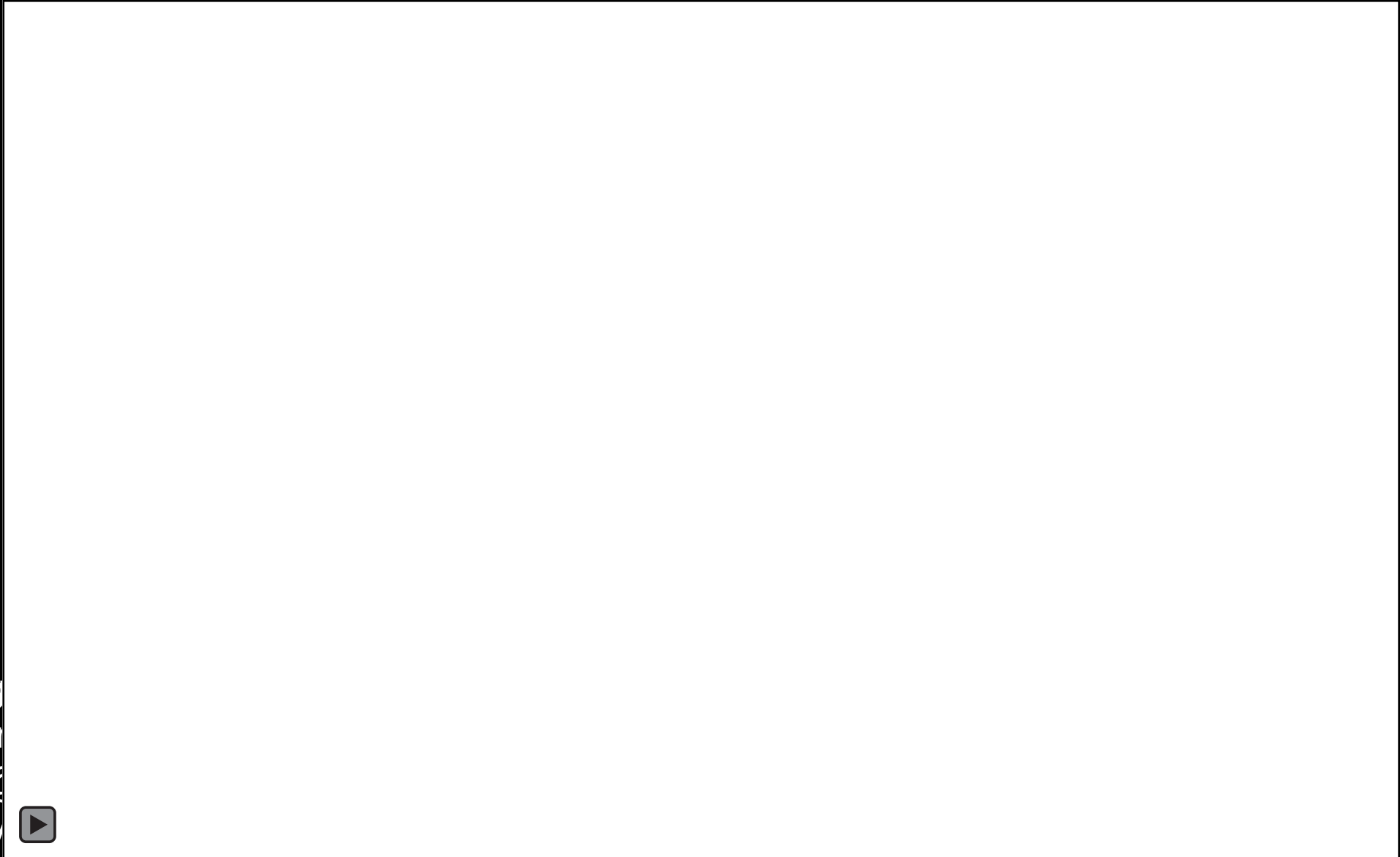
NAMES SUBMITTED TO  
TRAVEL TO THE SUN

 **JOHNS HOPKINS**  
APPLIED PHYSICS LABORATORY





***It has been almost 60 years since the Parker***



<http://nasa.gov>

<http://solarprobe.nasa.gov>

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***We are on our way!***