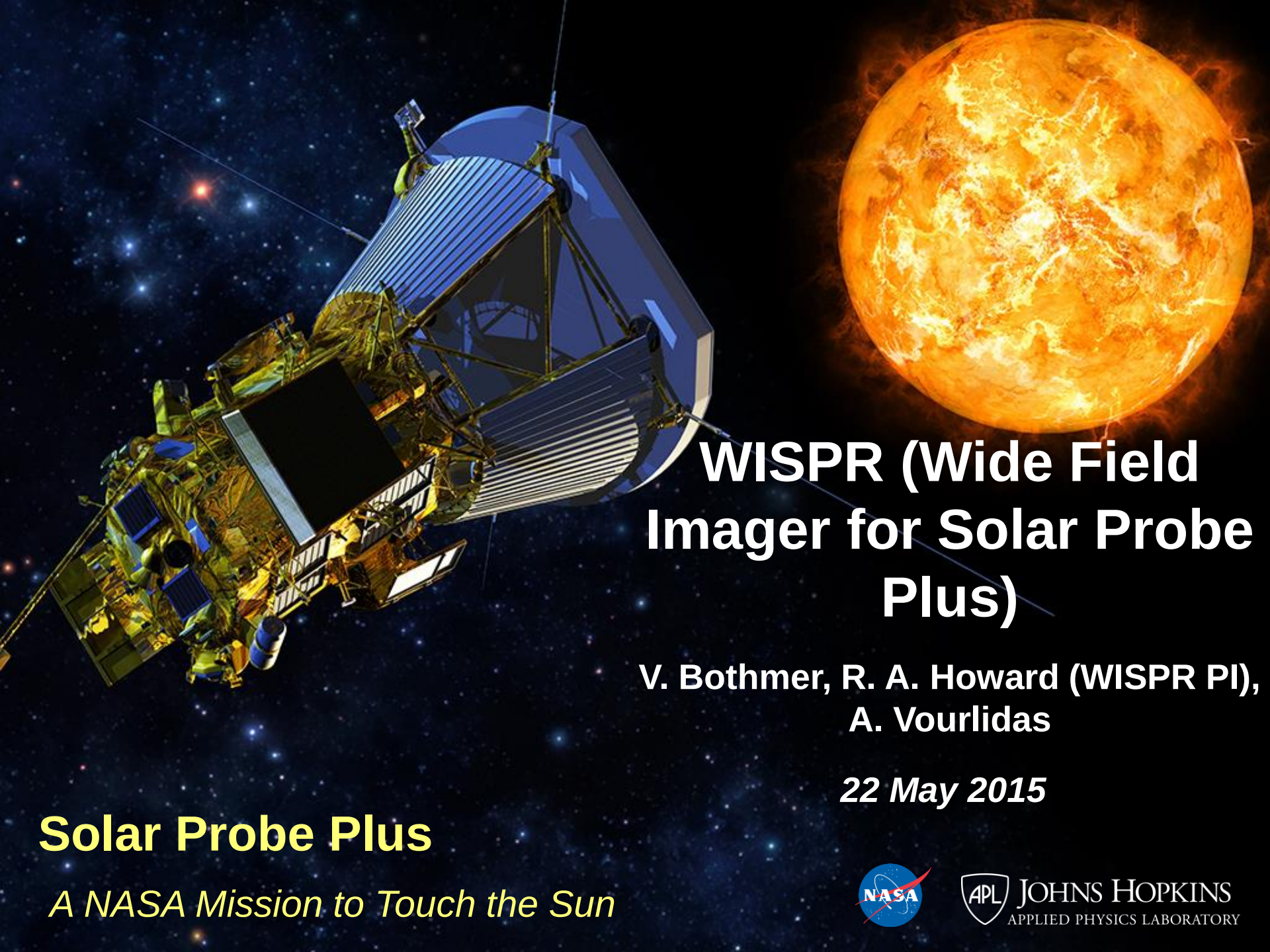


WISPR (Wide Field Imager for Solar Probe Plus)

V. Bothmer, R. A. Howard (WISPR PI), A. Vourlidas

22 May 2015

Solar Probe Plus

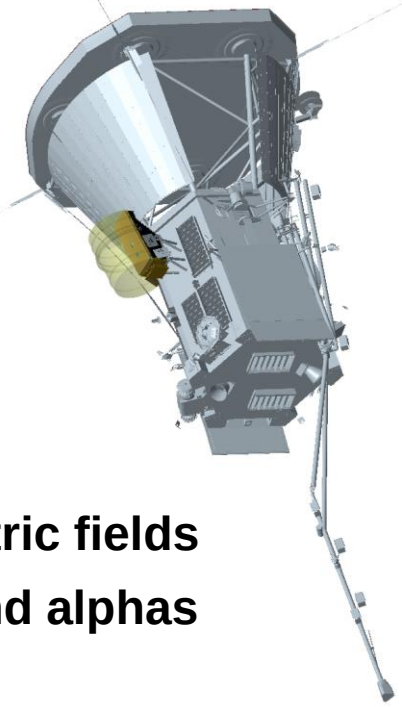
A NASA Mission to Touch the Sun

NASA

APL JOHNS HOPKINS APPLIED PHYSICS LABORATORY

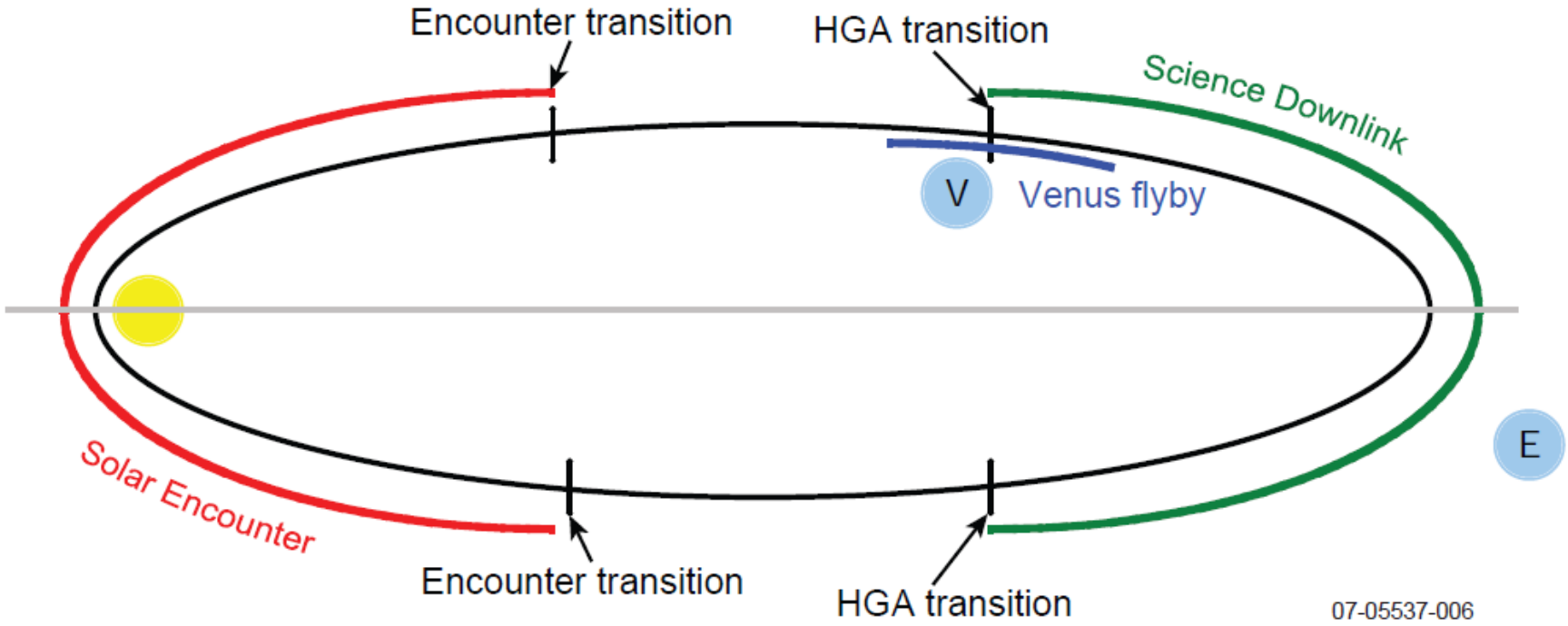
What is Solar Probe Plus (SPP)

- **Goes to the last unexplored region of the solar system and enter the solar corona as close as 9.86 Rs**
- **Will answer fundamental questions of Heliophysics:**
  - **The heating of the solar corona**
  - **The origin, structure and evolution of the solar wind**
  - **Origin of solar energetic particles**

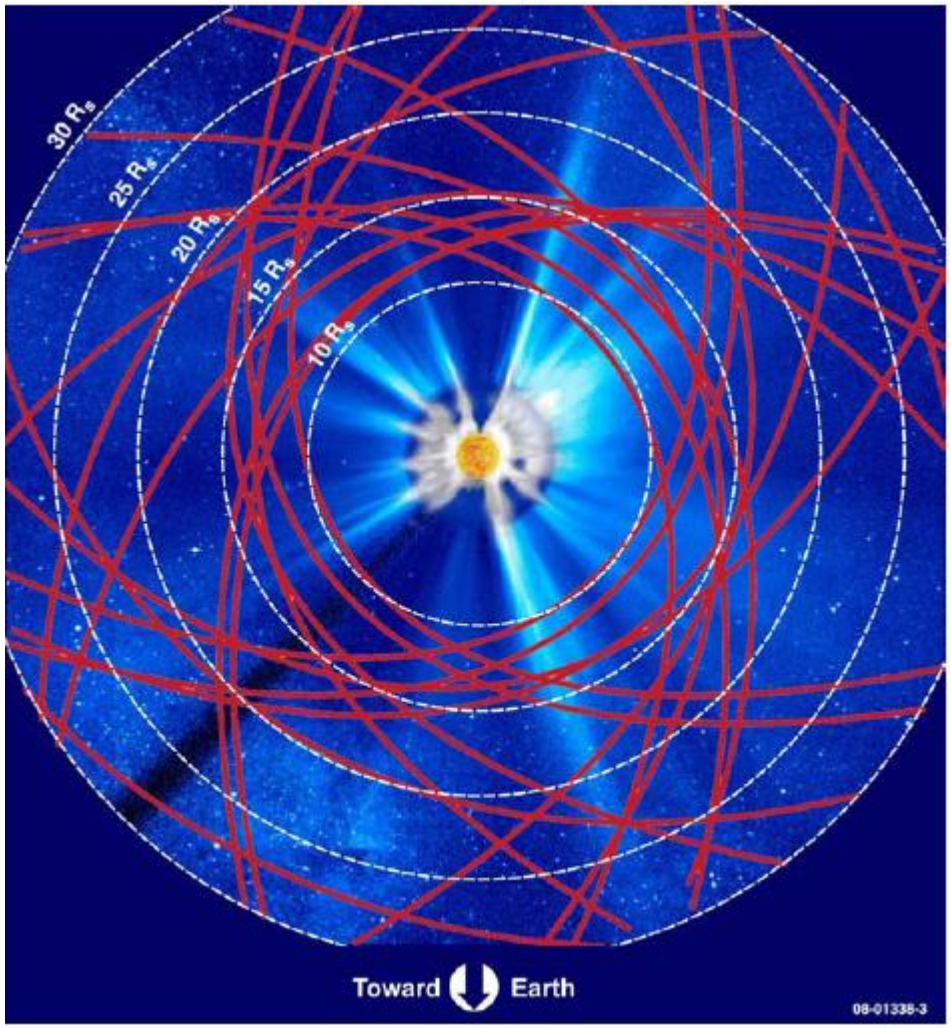


- **Investigations:**
  - **FIELDS: measurements of magnetic fields, AC/DC electric fields**
  - **SWEAP: measurements of flux of electrons, protons and alphas**
  - **ISIS: measurement of solar energetic particles**
  - **WISPR: measurement of coronal structures**
  - **Observatory Scientist**

SPP Mission Scenario – Observations
from 0.25 AU to 9.86 R_S



SPP Near Sun Perihel Passages

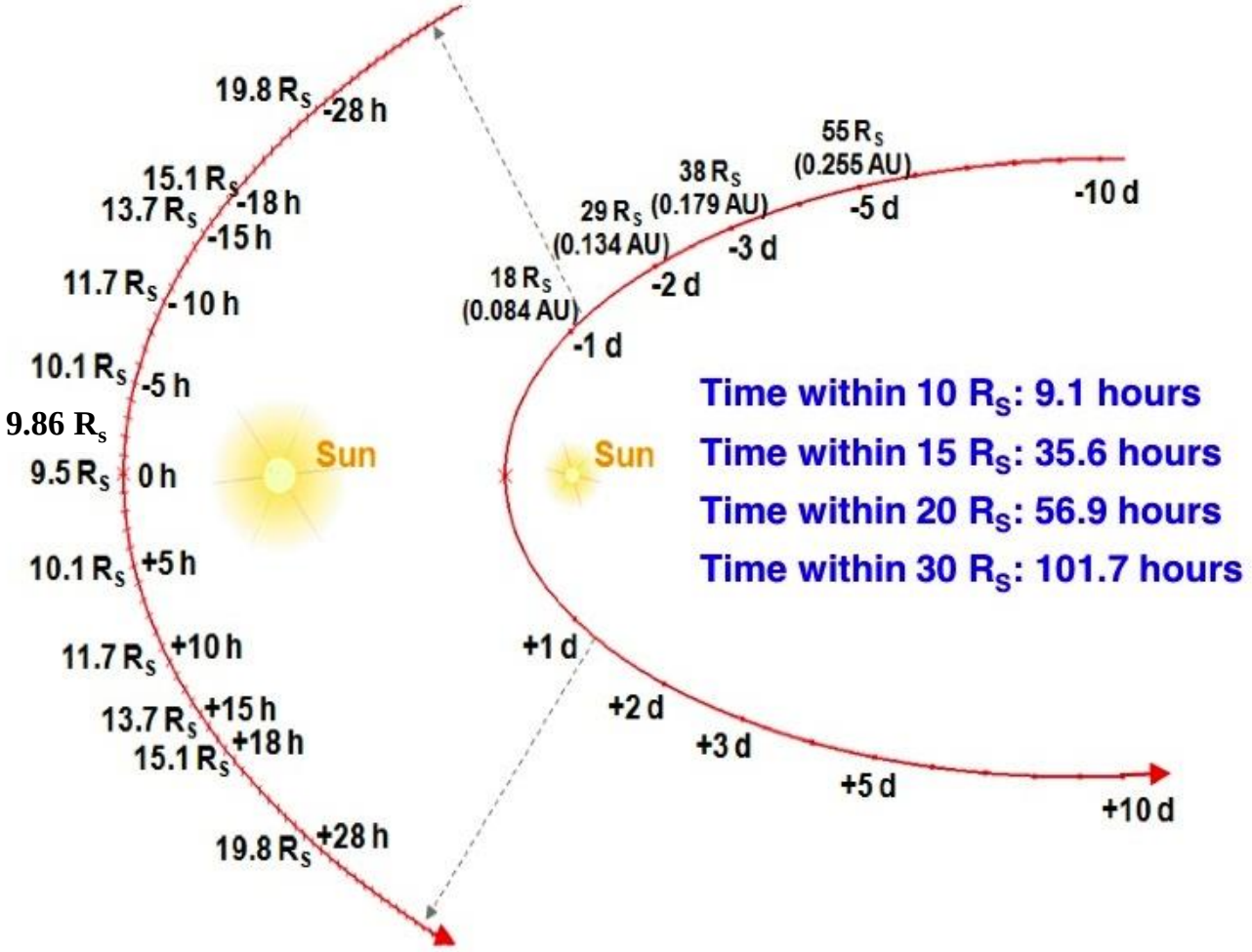


Number of Perihel passages < 30 R_S (0.14 AU):

- First Perihel at 35 R_S (0.16 AU) after 88 days
- 24 Perihel-passages over the time periofd of 7 years after launch in July 2018
- 1000 hrs of measurements at distances < 20 R_S

Ref.: NASA STDT

Solar Probe Plus Encounter Portion of the Orbit



Science Objectives

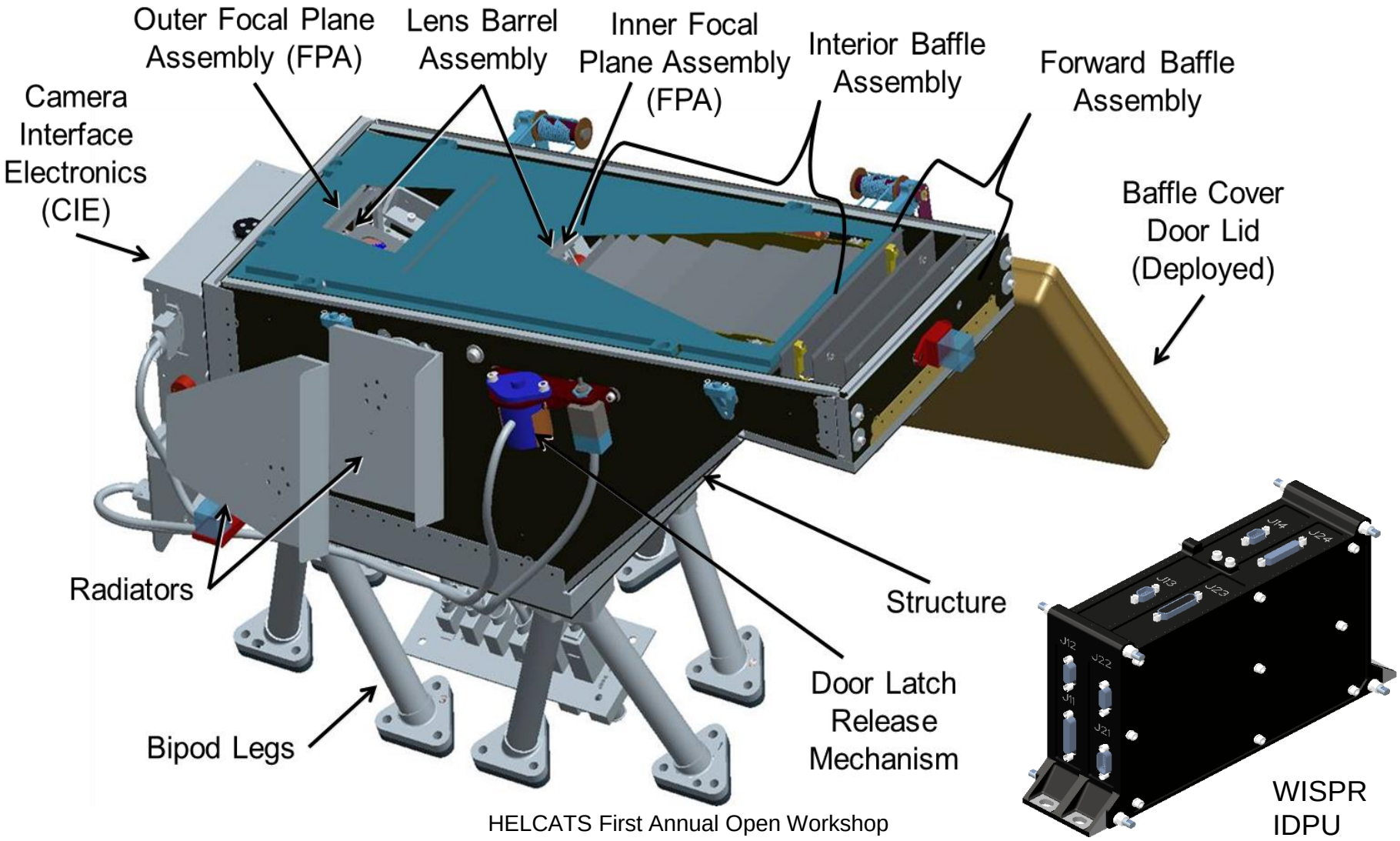
SPP Level-1 Science Objectives

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

To address these objectives, WISPR will:

- Derive the 3D structure of the solar corona through which the in-situ measurements are made to determine the sources of the solar wind.
- Provide density power spectra over a wide range of structures (e.g., streamers and pseudostreamers, equatorial coronal holes) for determining the roles of turbulence, waves, and pressure-balanced structures in the solar wind.
- Measure the physical properties (speed, density jump) of SEP-producing shocks and their CME drivers as they evolve in the corona and inner heliosphere.

What is WISPR (Wide Field Imager for Solar Probe Plus) Instrument Overview

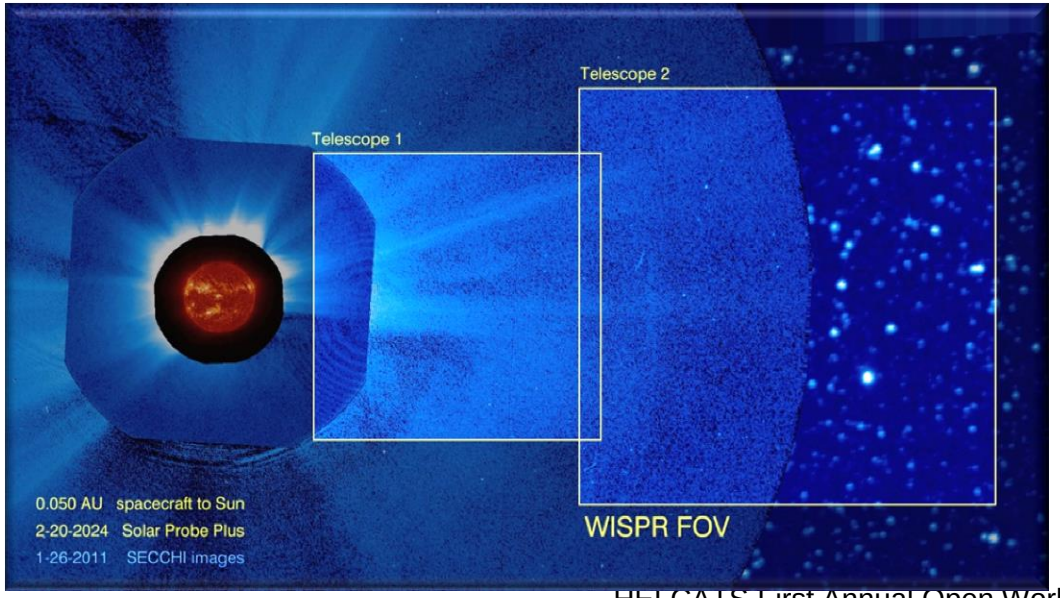


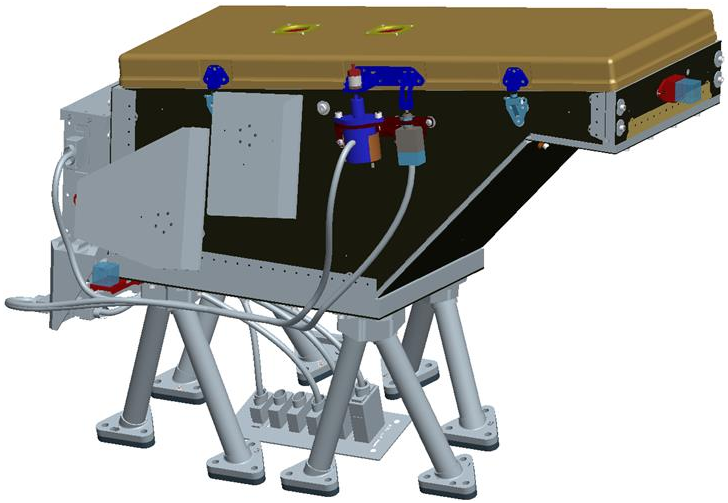
WISPR
Instrument Design Characteristics

Instrument Subsystem	Baseline Design Capability
Telescope Description	**Two White Light Telescopes with Wide Angle Lenses**
Bandpass	475 to 755 nm
Detector Field of View	38R x 40T Inner; 55R x 59T Outer
Radial Scene Coverage	13 - 104 degrees
Optical Resolution	4.2 arcmin Inner; 5.3 arcmin Outer
Focal Length and f-Number	EFL 27.4mm F/3.73 Inner; EFL 20.12mm F/3.99 Outer
Effective Aperture Area	9.7mm^2 Inner; 5.1 mm^2 Outer
Front Baffle Description	**Sequential diffraction from SPP TPS Trailing Edge and 3 Linear Front Baffles**
Detector Type	**SRI 5-T PPD Active Pixel Sensor (APS) Detector Jazz 0.18 um process**
Detector Package	2048 x 1920 APS Detector
Array Format	10 um by 10 um pixels
Digitization	14 bit ADC
Quantum Efficiency	> 24% accerage over 470 to 755 nm
Operating Temperature	-75 to -45; cooled with passive cold finger radiator
Operating Modes	Progressive Scan, Global Reset (test)
Readout Rate	~2 Mpixels/s
	Detector High Gain Mode
Linear Full Well Capability (95% of pixels)	20,000 to 21,300 e-/pixel
Read Noise (EOL, 95% of pixels)	7 e-/pixel
Dark Current (EOL, 95% of pixels)	2 e-/s/pixel @ -55 C
Mechanism	Flight-proven TiNi ERM-500 shaped memory alloy mechanism for one-shot door deployment with custom resistance

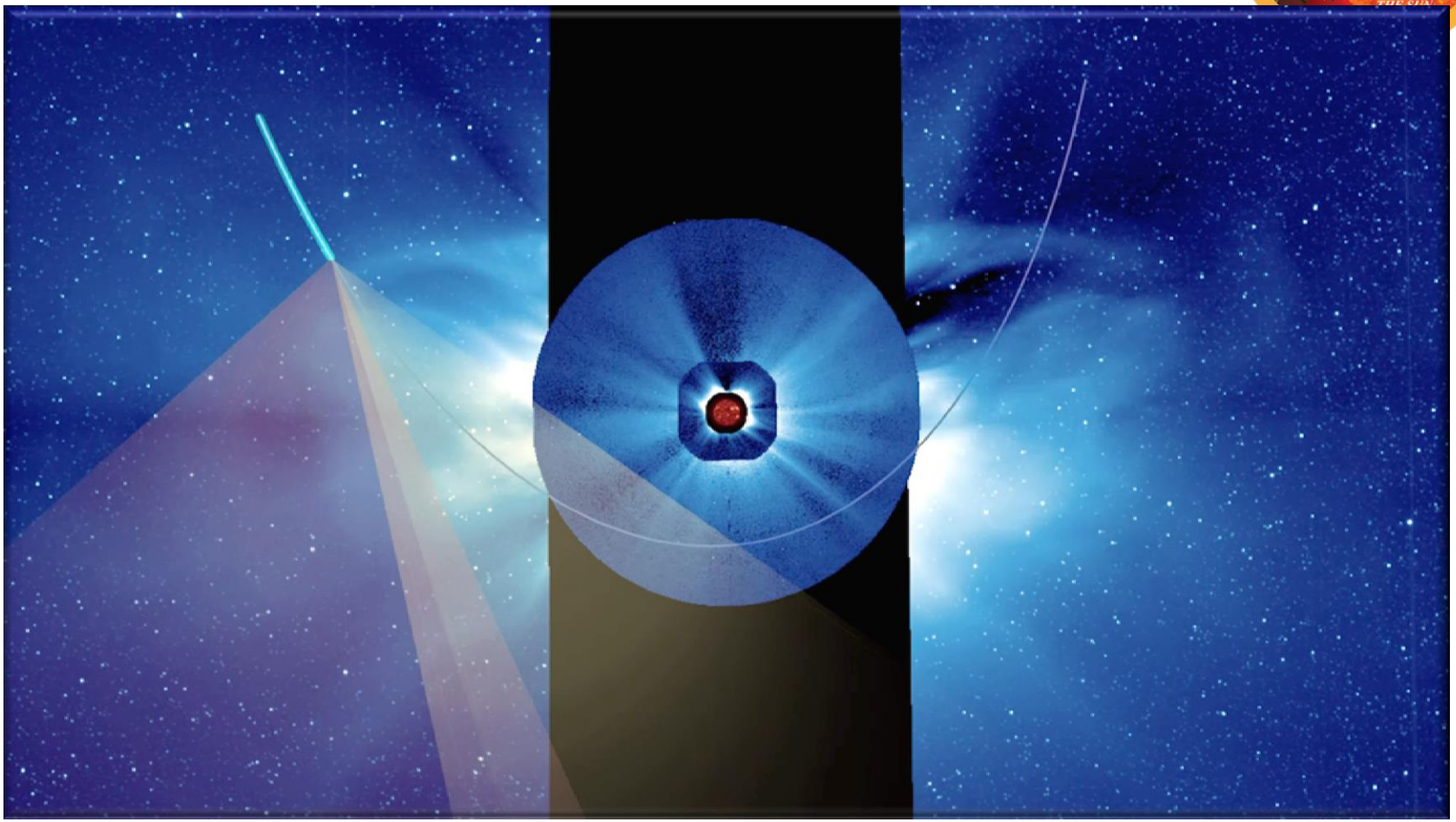
WISPR
Science Overview

- **Wide-Field, Visible Light Imager : 13.5º - 105º from the Sun.**
- **WISPR will map the morphology, velocity, acceleration and density of evolving solar wind structures when they are close to the Sun, as they approach, and then as they pass over the spacecraft**
- **Small density "blobs" accelerate to 30 Rs – is this occurring all the time?**
- **Shocks are seen ahead of CMEs – When do they form and are they the source SEPs?**
- **Streamer belt has longitudinal density fluctuations – What is this due to?**





Simulation of WISPR Observations During a 10Rs SPP Perihelion



View from above ecliptic. Based on STEREO/SECCHI observations from 1 AU. The two WISPR telescope FOVs are shown in color with the extent representing their sensitivity range as a function of distance.

WISPR
Suite Science and Approach in WISPR Paper

Space Sci Rev
DOI 10.1007/s11214-014-0114-y

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

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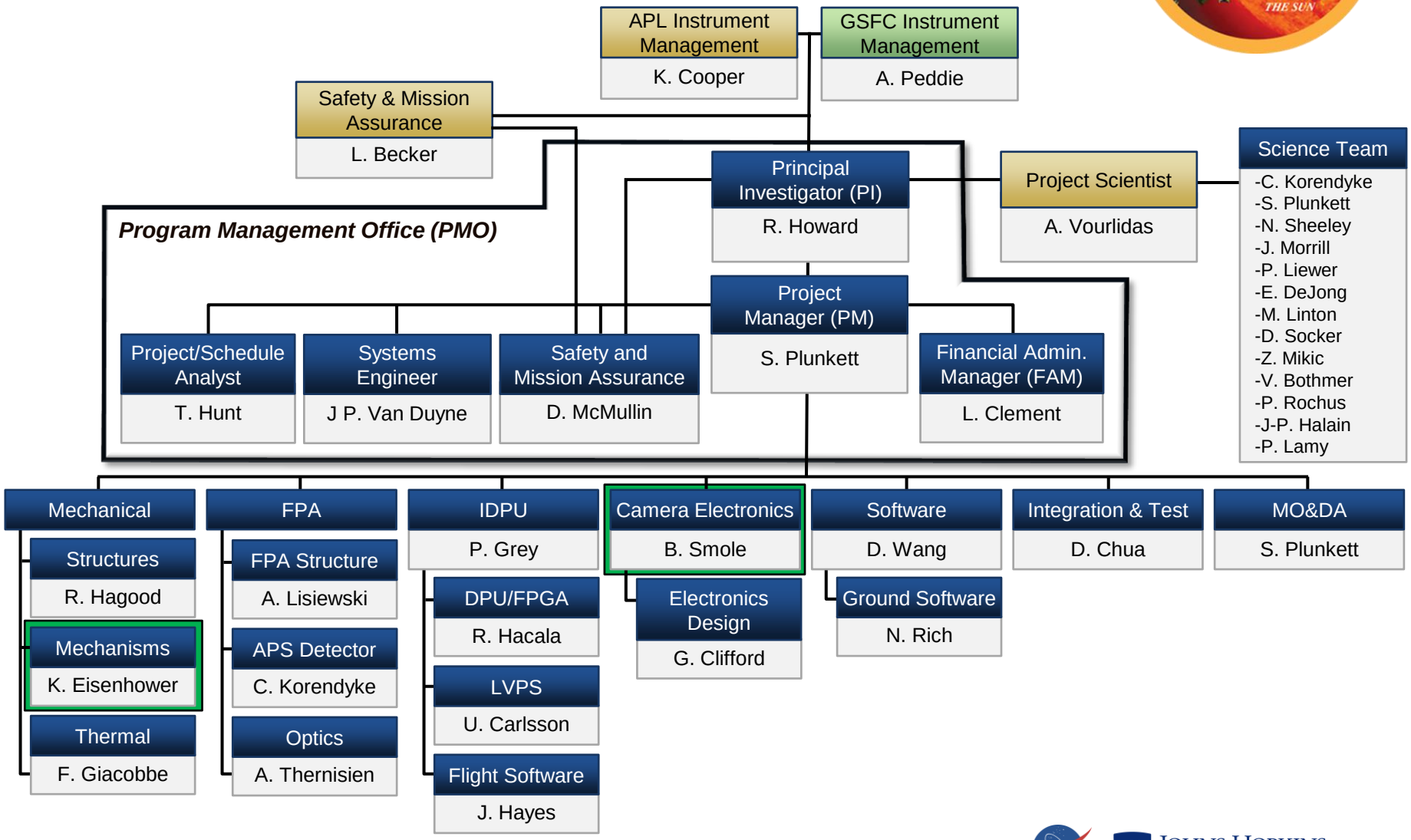
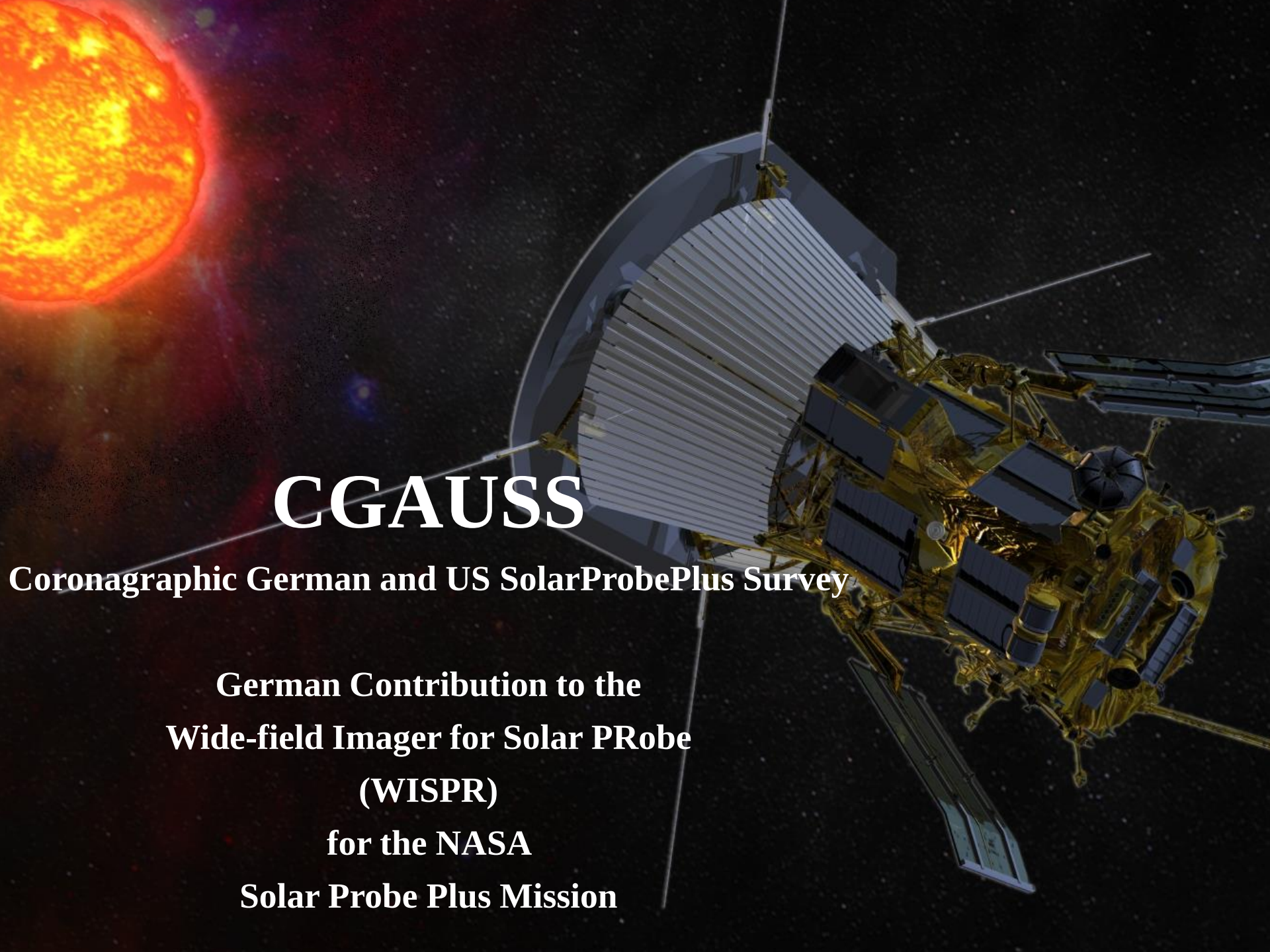
Received: 20 March 2014 / Accepted: 20 October 2014

WISPR
Team Organization





CGAUSS

Coronagraphic German and US SolarProbePlus Survey

German Contribution to the
Wide-field Imager for Solar PRobe
(WISPR)
for the NASA
Solar Probe Plus Mission

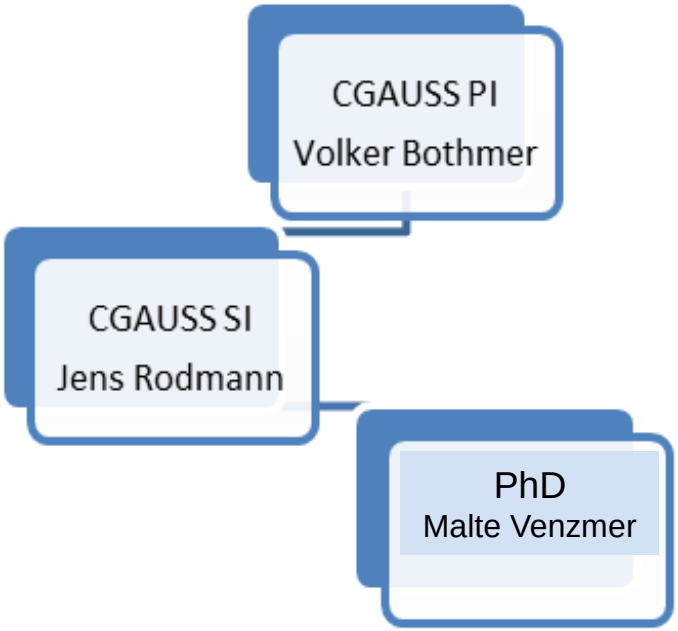
CGAUSS (Coronagraphic German And US SolarProbePlus Survey) – German Contribution to WISPR on SPP

DLR-NASA (Implementing Arrangement): 03/2012-09/2026

Mission Operations Planning and Data Analysis

- Overall Project Management and 3-D Reconstruction of Static and Coronal Strructures
- Modelling of Dustparticle and F-Corona Distribution for SPP Orbit including Physics of Dusty Plasmas
- Investigation and Analysis of Dustparticle Impacts on SPP WISPR Material Surfaces
- Helios Plasma and Dustparticle Data Analysis and Extrapolation for SPP Orbit

CGAUSS Team

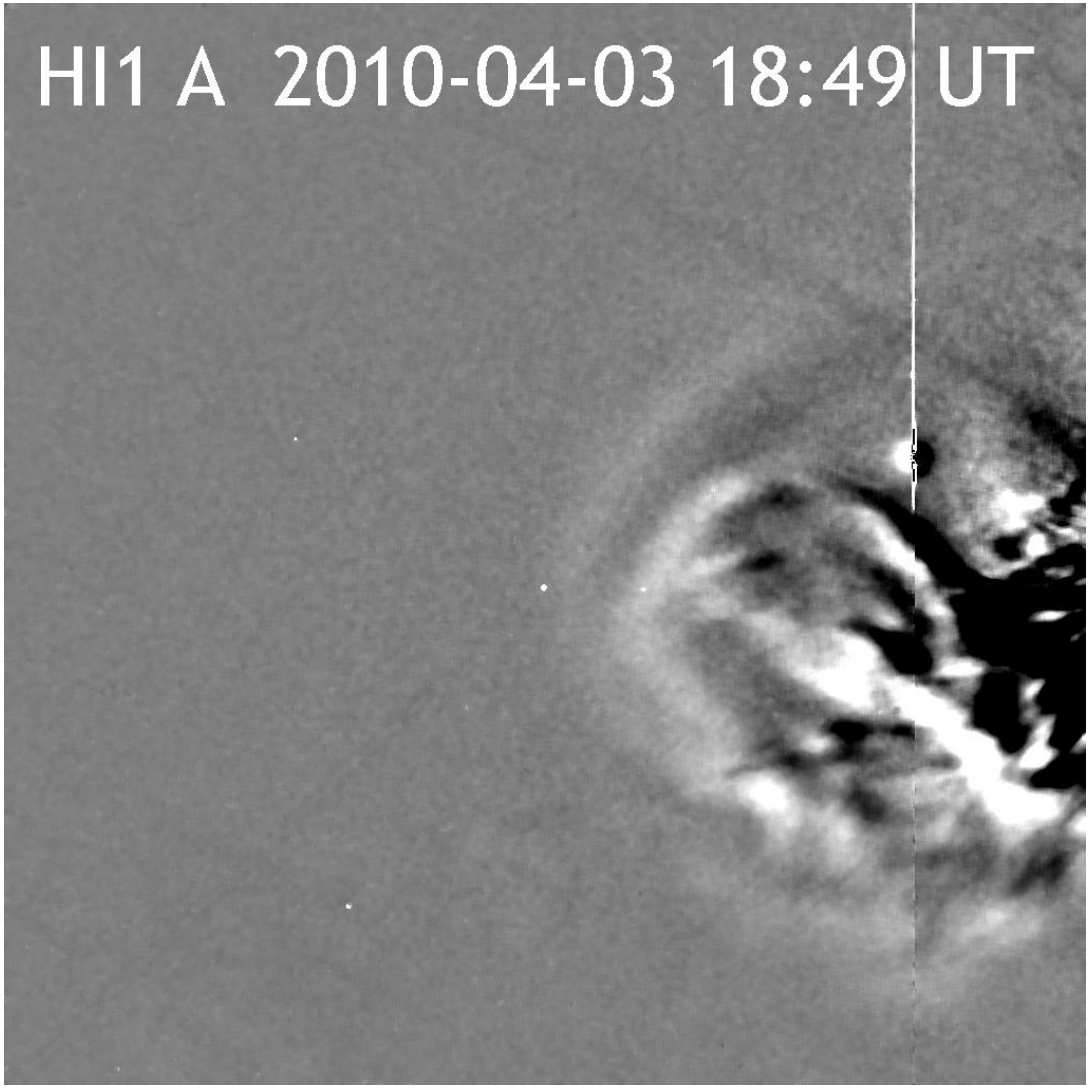


National Collaborators:
Ralf Srama and Team
@ MPIK Heidelberg

WISPR will Provide High Cadence Observations at Perihelion

				Baseline Science Measurement Requirements	
ID	Reqt Title	Region	Elongation	Full Frame	Inner FOV Subframe
1.7	Cadence	0.044 to 0.07 AU	14° to 37.3°	≤ 2 min	≤ 8 sec
			37.3° to 61.25°	≤ 4 min	
			61.25° to Radial Outer FOV	≤ 12 min	
		0.07 to 0.11 AU	14° to 37.3°	≤ 5 min	
			37.3° to 61.25°	≤ 15 min	
			61.25° to Radial Outer FOV	≤ 15 min	
		0.11 to 0.174 AU	14° to 37.3°	≤ 16.5 min	
			37.3° to 49.3°	≤ 33 min	
			49.3° to Radial Outer FOV	≤ 33 min	
		0.174 to 0.255 AU	14° to 37.3°	≤ 12 min	
			37.3° to 49.3°	≤ 36 min	
			49.3° to 69.4°	≤ 72 min	
1.8	Spacecraft Distance from Sun			0.044 to 0.25 AU	0.044 to 0.07 AU
1.9	Daily Observing Period			24 hrs	≥ 6 hrs (15 min image sequence every hr)
1.10	Orbital Observing Period			10	≥ 1.5
1.11	Baseline Mission Observing Period	0.044 to 0.255 AU	0.044 to 0.255 AU	≥ 240	
		0.044 to 0.07 AU	0.044 to 0.07 AU	≥ 15	≥ 15
		0.07 to 0.11 AU	0.07 to 0.11 AU	≥ 20	

WISPR will Provide High Cadence Observations at Perihelion



Courtesy: L. Volpes

WISPR will image and detect in-situ CME shock waves and structures in high resolution

Summary and Conclusions

- **WISPR Will Image**
  - **Slow and Fast Solar Wind Structures and Fluctuations Directly.**
  - **CMEs and Shocks and Follow their Propagation, Evolution, and Connection to the Site of Production of SEPs.**
- **WISPR Will Measure Electron Density Turbulence**
  - **Fast Cadence Readout Mode to Generate Power Spectral Density to Compare to *in-situ* Observations of Density and Magnetic Field Spectral Density.**
- **WISPR Provides the Links Between the**
  - **Solar Wind Structure and SPP *in-situ* Instruments.**
  - **Solar Orbiter and Solar Probe+ Missions**