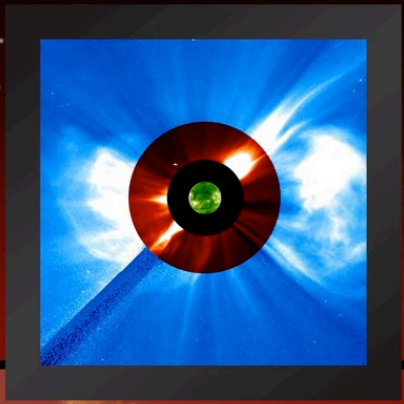
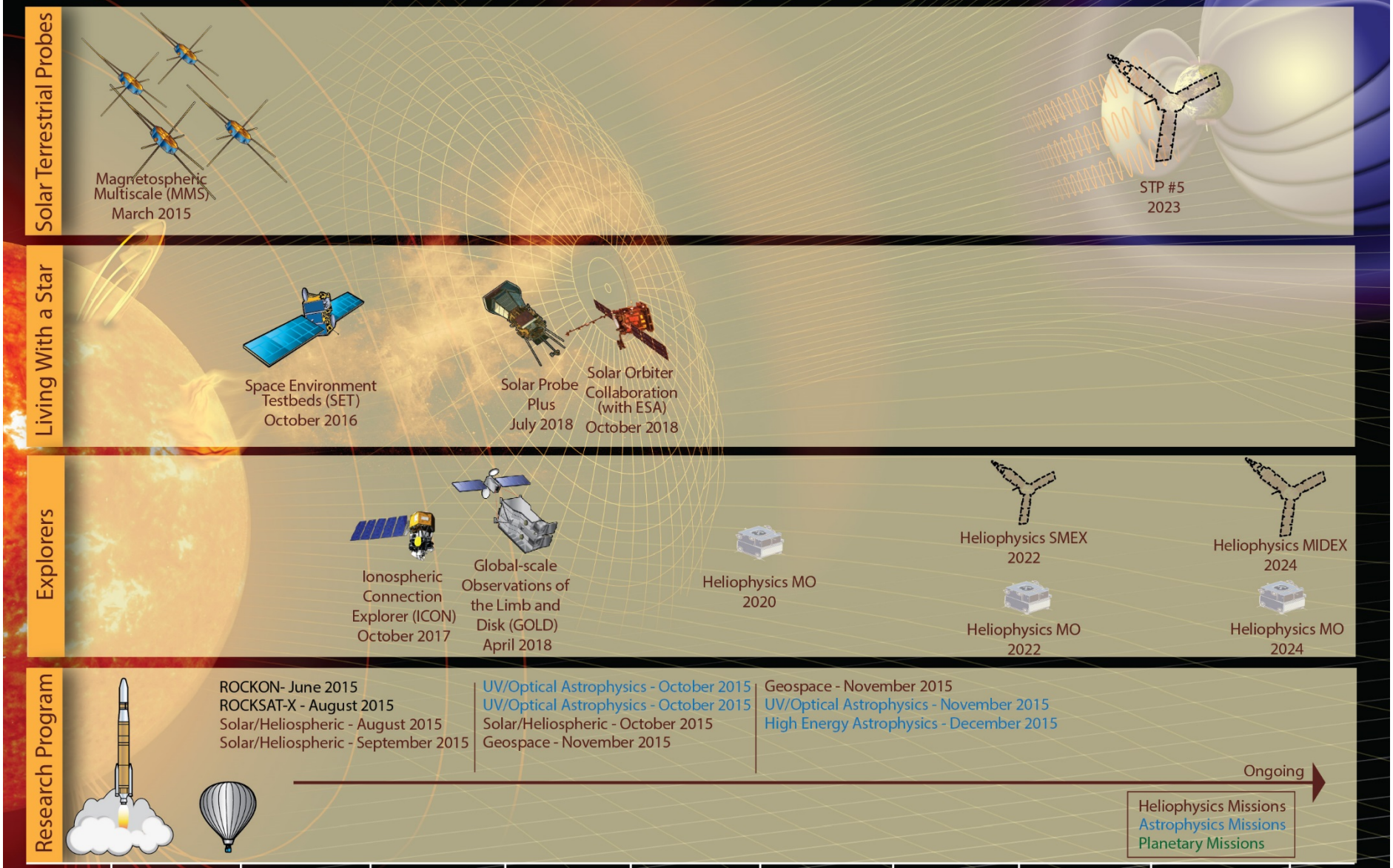
National Aeronautics and Space Administration

HELIOPHYSICS DIVISION

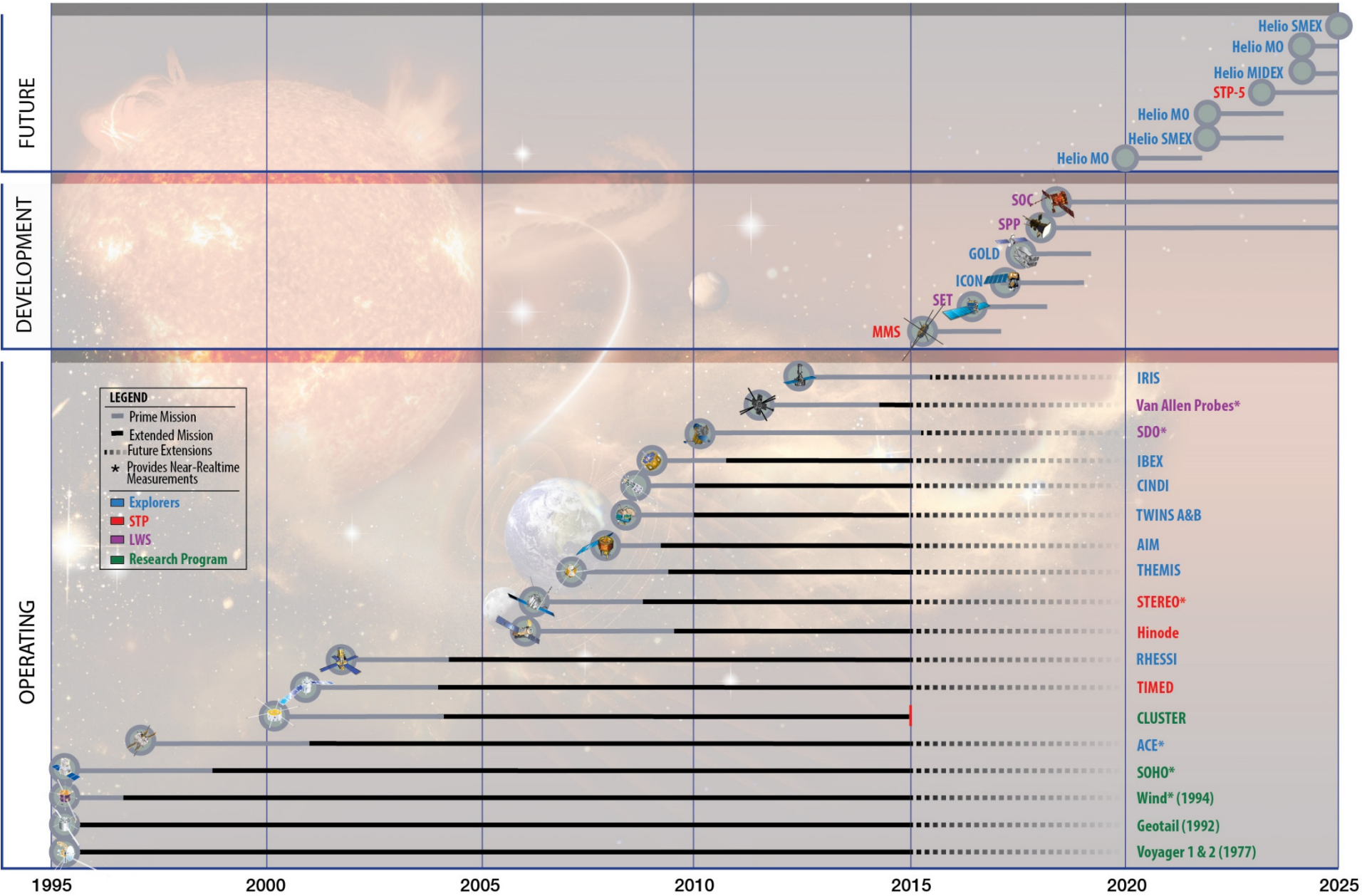


Programmatic Overview
presented to HPS
30 June 2015
Sandra Smalley

Heliophysics Program 2015-2024



Heliophysics Mission Timeline 1995-2025



MMS Significant Progress Highlights

Description: The Magnetospheric Multiscale (MMS) mission is a Solar Terrestrial Probes mission comprising four identically instrumented spacecraft that will use Earth's magnetosphere as a laboratory to study the microphysics of three fundamental plasma process: magnetic reconnection, energetic particle acceleration, and turbulence.

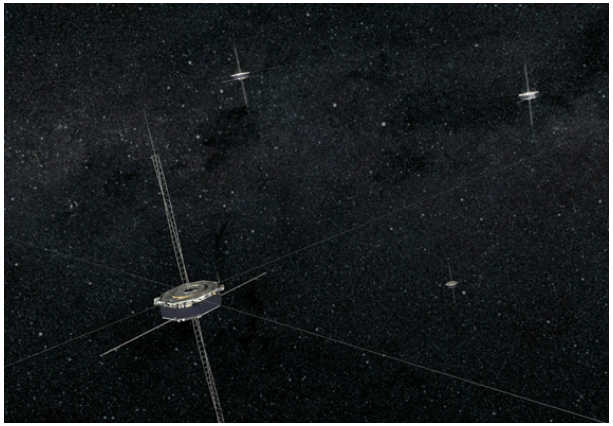
The MMS constellation's orbit, spin rates and attitudes are nominal, all spacecraft systems are performing well, all communications networks (DSN TDRS, NEN) functioning nominally.

Upcoming Milestones:

- MMS formation achieved July 16
- Post Launch Assessment Review (PLAR) scheduled for Aug 25, 2015
- Begin Prime Phase Operations Sep 1, 2015

Recent Accomplishments:

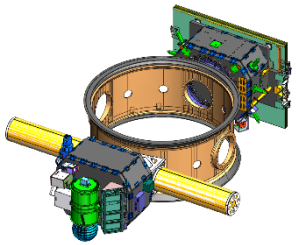
- ✓ Mag Boom Deployments – completed
- ✓ Perigee Burns – completed
- ✓ SDP Deployments – completed April 23rd
- ✓ ADP Deployments – May 8
- ✓ Eclipse Period – May 12 – June 21
- ✓ Orbit alignment with Van Allen Probes June 12.
- ✓ All software uploads in place on CDIP and C&DH units June 17
- ✓ SOC at LASP, with SITL, functional
- ✓ MOC at GSFC, with Flight Dynamics teams, functional

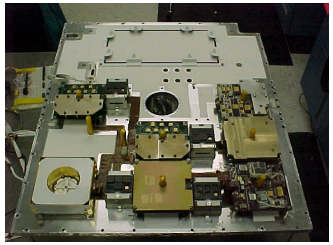


Watch Items/Concerns:

- In July, due to conflict with New Horizons approach to Pluto, DSN availability being balanced against service from Santiago Station– this disruption will likely have low impact on the commissioning
- Observatory #3 attempt to warm up the –Z ADP boom and perturb it with thruster firing was unsuccessful. Boom is 3 % short of full deployment. No impact to science. No further attempts to deploy are planned.

LWS Space Environment Testbeds (SET)-1





Launch Information:

- **Spacecraft:** AFRL Deployable Structures Experiment (DSX)
- **Launch Vehicle**: SpaceX Falcon Heavy
- **Date**: October 2016
- **Site**: Cape Canaveral
- **Orbit**: 6000 x 12,000 km, 45 degee inclination MEO

Description:
Space Environment Testbeds (SET) improves the engineering approach to accommodate and/or mitigate the effects of solar variability on spacecraft design and operations by: 1) collecting data in space to develop a physics-based understanding of response of spacecraft materials, components, & sensors/detectors to space environments; 2) collecting data in space to validate new & existing ground test protocols for the effects of solar variability on emerging technologies; 3) developing & validating engineering environment models, tools, & databases for spacecraft design & operations

Upcoming Milestones:

- Complete Vibration and TVAC testing Aug 2015
- Launch October 2016

Accomplishments:

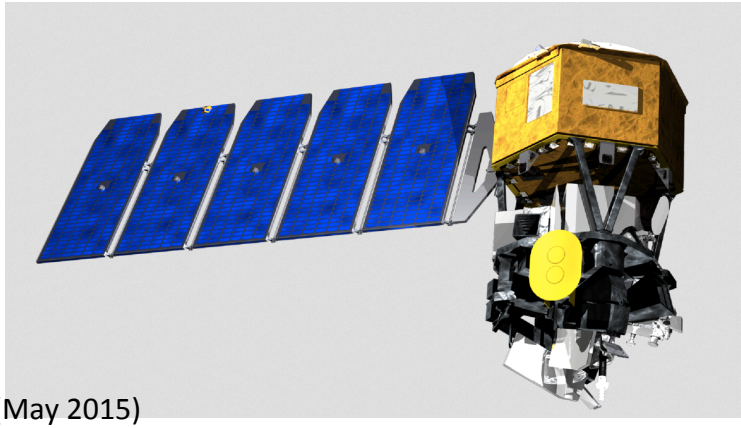
- ✓ All flight hardware has been delivered, including the separation system for the DSX secondary payload.
- Preparations for the data interface between AFRL and GSFC have started.
- Activities scheduled for FY16 include work with the separation system, mission readiness review (MRR), and 4 mission rehearsals.

Watch items/Conerns:

- None

ICON
- Ionospheric Connection Explorer -

Description: ICON will explore the boundary between Earth and space to understand the physical connection between our world and our space environment. It is a Category 2, Risk Class C Mission Launch on a Pegasus XL launching from Kwaj in October 2017. The spacecraft will be placed in a LEO Orbit at 575 km with a 24°inclination. The spacecraft consist of four instruments, MIGHTI (NRL) – neutral wind measurements; IVM (UT Dallas) - in situ ion velocities; and FUV & EUV imaging UV spectrographs (UC Berkeley) - O/N2, O+ ion density O/N2, O+ ion density



Upcoming Milestones:

- SIR – June 2016
- PER – August 2016
- LRD – Oct 2017

Recent Accomplishments:

- ✓ All Spacecraft components under contract (Apr 2015)
- ✓ Mission CDR completed April 9, 2015
- ✓ Mission Operation Engineering Peer Review r May 2015
- ✓ Spacecraft structure fabrication completed and structural load testing progressing (May 2015)
- ✓ Harness mockr up completed and flight harness fabrication initiated (May 2015)
- ✓ Solar array substrates completed (May 2015)
- ✓ MRRs conducted for Antenna, Star Trackers, Battery, Transponder, IMAU, GPS, SADA & RWAs (May 2015).
- ✓ ICP EM vibration testing completed (Jun 2015).
- ✓ ICON Mission Avionics Unit (IMAU) has completed the integrated functional test (Jun 2015).
- ✓ MIGHTI EM completed and started vibration testing (Jun 2015).
- ✓ FUV flight optics coating completed (Jun 2015).

Watch items/Concerns:

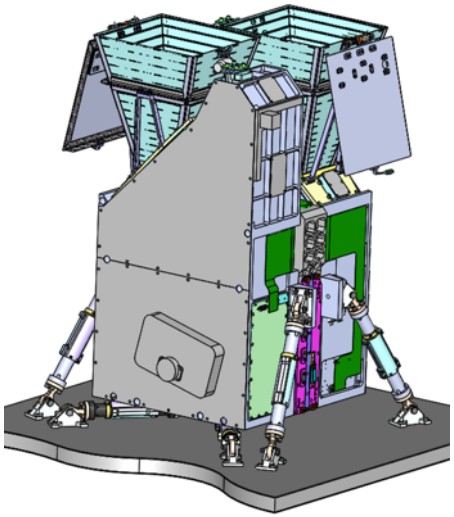
- EUV coating delamination
- FUV Turret Resonance frequency lower than
- required. Evaluating launch site options.

GOLD
- Global Observations of the Limb And Disk -

Description: GOLD is an Explorer Program Mission of Opportunity that will provide the first simultaneous measurements of temperatures and composition in Earth's thermosphere and ionosphere on a global scale. GOLD will fly an UV imaging spectrograph as a hosted payload on a commercial communications spacecraft in geostationary orbit.

Upcoming Milestones:

- CDR - July 2015 (TBR)
- Pre-Environmental Review - March 2016
- Pre-Ship Review - September 2016
- Launch Readiness Date - April 2018



Recent Accomplishments:

- ✓ Signed LASP and SES-GS contract for spacecraft accommodations in Apr
- ✓ Scan mechanism in TVAC
- ✓ Aperture door life testing completed
- ✓ Held SES-14 Accommodation Workshop May 6-7, 2015
- ✓ Completed spacecraft TIM2 in Toulouse, France, June 2 – 4, 2015
- ✓ S/C Technical Interchange Meeting (TIM 2) conducted June 2–4
- ✓ Life testing completed for EM GYM, Slit, & Door mechanisms.

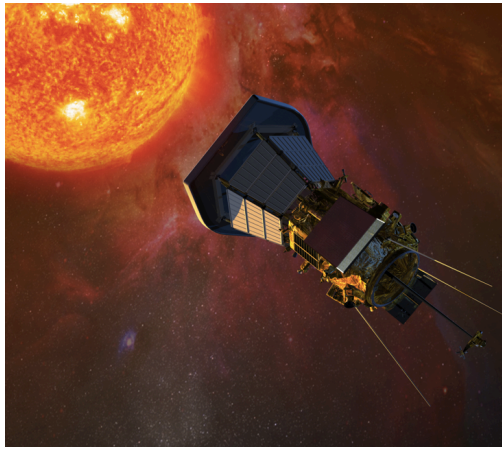
Watch Items/Concerns:

- IBR and CDR readiness assessment results by Program Office indicate Project not ready; mitigation steps being taken; CDR delay to Fall 2015 most likely

Solar Probe Plus

Description

Spacecraft in a highly eccentric elliptical orbit with a minimum perihelion of 9.9 Solar Radii (~4.3 million miles). Employs a combination of in-situ measurements and imaging to achieve the mission's primary scientific goal: to understand how the Sun's corona is heated and how the solar wind is accelerated.



Upcoming Milestones

- SIR - June 2016
- LRD - July 2018

Recent Accomplishments

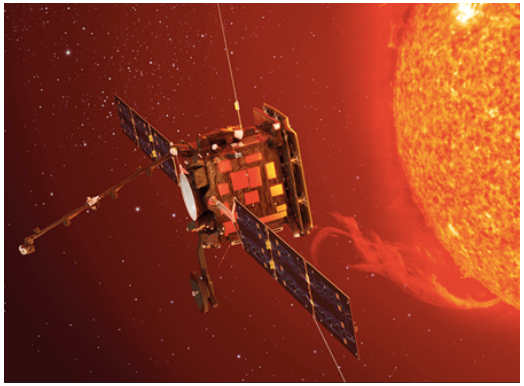
- ✓ Mission CDR completed 20 March
- ✓ Conducted JHU/APL EVMS Compliance Review May 11 – 15.
- ✓ SWEAP passed CDR Part 2 on June 3.
- ✓ Conducted ULA/Orbital Delta IV Heavy Launch Vehicle Kickoff Meeting June 17.
- Identified preferred solution to address reduces FIELDS whip antennas excessive loads. Testing of viable designs anticipated to be completed by mid-July.

Watch items/Concerns

- S/C magnetic fields on SWEAP Span A and B – modeling in process
- SWEAP replan may result in cost growth
- Significant loads on FIELDS Whip antenna.

Solar Orbiter: The Sun Up Close, to Understand How the Sun Creates and Controls the Heliosphere

Description: Will use a unique combination of measurements: *In situ* measurements will be used alongside remote sensing, close to the Sun (~.3 AU), to relate these measurements back to their source regions and structures on the Sun's surface. Operates both in and out of the ecliptic plane. Measures solar wind plasma, fields, waves and energetic particles close enough to the Sun to ensure that they are still relatively pristine.



Upcoming Milestones:

- LRD October 2018

Recent Accomplishments:

- ✓ KDP-C March 2013– For NASA-contributed instruments (HIS, SoloHI)
- ✓ CDR board meeting held on Jun 17
- ✓ Completed HIS Electrical Model (ELM) testing with the suite level Data Processing Unit (DPU) ELM.
- Spare Flight Solid State Detector (SSD) radiation life test at GSFC is ongoing.
- SoloHI Integration and Test Underway
- ✓ SoloHI Electrical Model Delivered and Integrated on ESA Solar Orbiter Electrical Test Bed (ETB) - *First SO Instrument to Successfully Send Data Through the ETB*
- SoloHi Flight assembly of the interior baffle box and assembly of FM Door Mechanism (hinges installed) has started.

Watch Items/Concerns:

- HIS Highr-Voltage Opto-Diode (glass) passivation qualification continues w/ backup options
- HIS detector High-voltage discharge failure review board is underway
- Delta CDR Fall 2015

Heliophysics Science Missions in Formulation & Development – June 2015

6/16/15

Project	Overall previous months -4	-3	-2	-1	O	This Month T	C	S	P	Comments
Development										
EX-GOLD Apr 2018	G	G	G	G	G	G	G	Y	Y	Evaluating readiness for IBR and CDR.
EX- ICON Oct 2017	G	G	G	G	G	Y	G	G	G	Foreign material detected on EUV grating coating; FUV Turret Resonance frequency lower than required. Evaluating launch site options.
LWS-SPP Jul 2018	G	G	G	G	G	Y	G	G	G	Technical: S/C magnetic fields on SWEAP Span A and B; SWEAP replan may result in cost growth; Significant loads on FIELDS Whip antenna.
LWS-SOC Oct 2018	G	G	G	G	G	Y	G	Y	G	HIS High-Voltage Opto-Diode (glass) passivation qualification continues w/ backup options. HIS detector High-voltage discharge FRB underway. Delta CDR Fall 2015. Overall Green: ABC - Oct 2018.
LWS – SET Oct 2016	G	G	G	G	G	G	G	G	G	
STP-MMS Mar 2015	G	G	G	G	G	G	G	G	G	Eclipse phase concluded Jun 21.

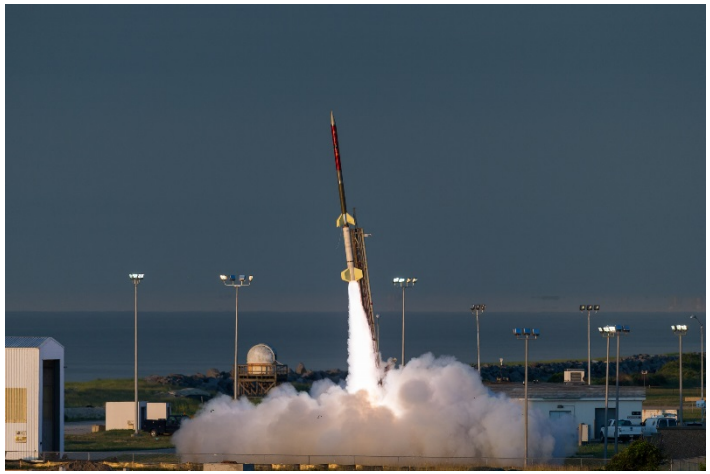
T: Technical, S: Schedule, P: Programmatic, C: $ resources, O: overall

On plan, adequate Margin

Problems, working to resolve within planned Margin

Problems, not enough margin to recover

Additional Heliophysics Division Status and Accomplishments (6/2015)



RockOn! Student Payload Jun 25

Upcoming Milestones:

- **Sounding Rockets** –Milliner (Special Projects) Jul 7,
  Koehler Rocksat-X (student outreach) Aug 11.
- **Explorers AO** – 2016
- **STP 5 AO** - 2017

Recent Accomplishments:

- ✓ **Senior Review** – Conducted Apr 21 – 24. Report release NLT 6/30.
- ✓ **2015 SOAR –** Heliophysics earns noteworthy progress
- ✓ **Sounding Rockets** - Koehler RockOn! (student) Launched Jun 25. Biannual Sounding Rockets Working Group Meeting held on 6/3. Woods successfully launched on May 21 but had to be cut down, payload recovered. Koehler, WI, 20 April. McEntaffer May 1, Koehler Rocksat Apr 17.
- ✓ **Black Brant** - Design Review for new MK4 motor completed April 21-22, first motor cast on 6/4/15.

Watch Items/Concerns:

- **Range:** Australian range sounding rocket campaign delayed until at least 2017.
- **Peregrine Motor Development**: Evaluating funding and options.
- **STEREO –** Reduced science data through 2016:
  - Stereo B not communicating; FRB complete and report issued 5/20. Recovery plan included 8 week test while sun-probe-earth (SPE) angle > 3.6° in May and June and resume recovery operations on 11/30 (SPE=3.9º); both will utilize weekly 3x3hr tracks on consecutive days to cover 72 hr CLT reset period. Recovery options will continue through 6/28, will be suspended through November due to solar interference resulting from spacecraft retrograde motion, and then restarted in November for 3 months.
  - Stereo A conjunction began 3/24 and lasts until 7/6. Total loss of communication expected.

Mission Suite

Mission	Launch	Phase	Extension to (*)	M-3	M-2	M-1	Cur. M.	Remarks
Geotail	7/24/92	Extended	12/31/2016					
STEREO	10/25/06	Extended	9/30/2018					A detected by GBT on 5/30 1.6R_sol from limb.
THEMIS+Artemis	2/17/07	Extended	9/30/2018					D PCM anomaly 5/17 - 6 hr lost
AIM	4/25/07	Extended	9/30/2018					
Hinode	9/23/06	Extended	9/30/2018					
Cluster	7/16/00	Extended	*9/30/2015 (+)*					Will cease to report after 10/1/2015
ACE	8/27/97	Extended	9/30/2018					
RHESSI	2/05/02	Extended	9/30/2018					
SOHO	12/02/95	Extended	9/30/2018					
TIMED	12/07/01	Extended	9/30/2018					
Voyager 1 + 2	8/20/77	Extended	9/30/2018					
TWINS A + B	6/06 & 3/08	Extended	9/30/2018					
CINDI:C/NOFS	4/16/08	Extended	12/31/2015					Reentry of C/NOFS due late CY2015
IBEX	10/19/08	Extended	9/30/2018					
Wind	11/01/94	Extended	9/30/2018					
SDO	2/11/10	Extended	9/30/2018					
Van Allen	8/30/12	Extended	9/30/2018					
IRIS	6/27/2013	Extended	9/30/2018					

Mission proceeding to meet science requirements

Area of concern - possible reduction in capability

Significant problem - possible or probable loss of mission