National Aeronautics and Space Administration

NASA Heliophysics Update
Committee on Solar and Space Physics
05 October 2016

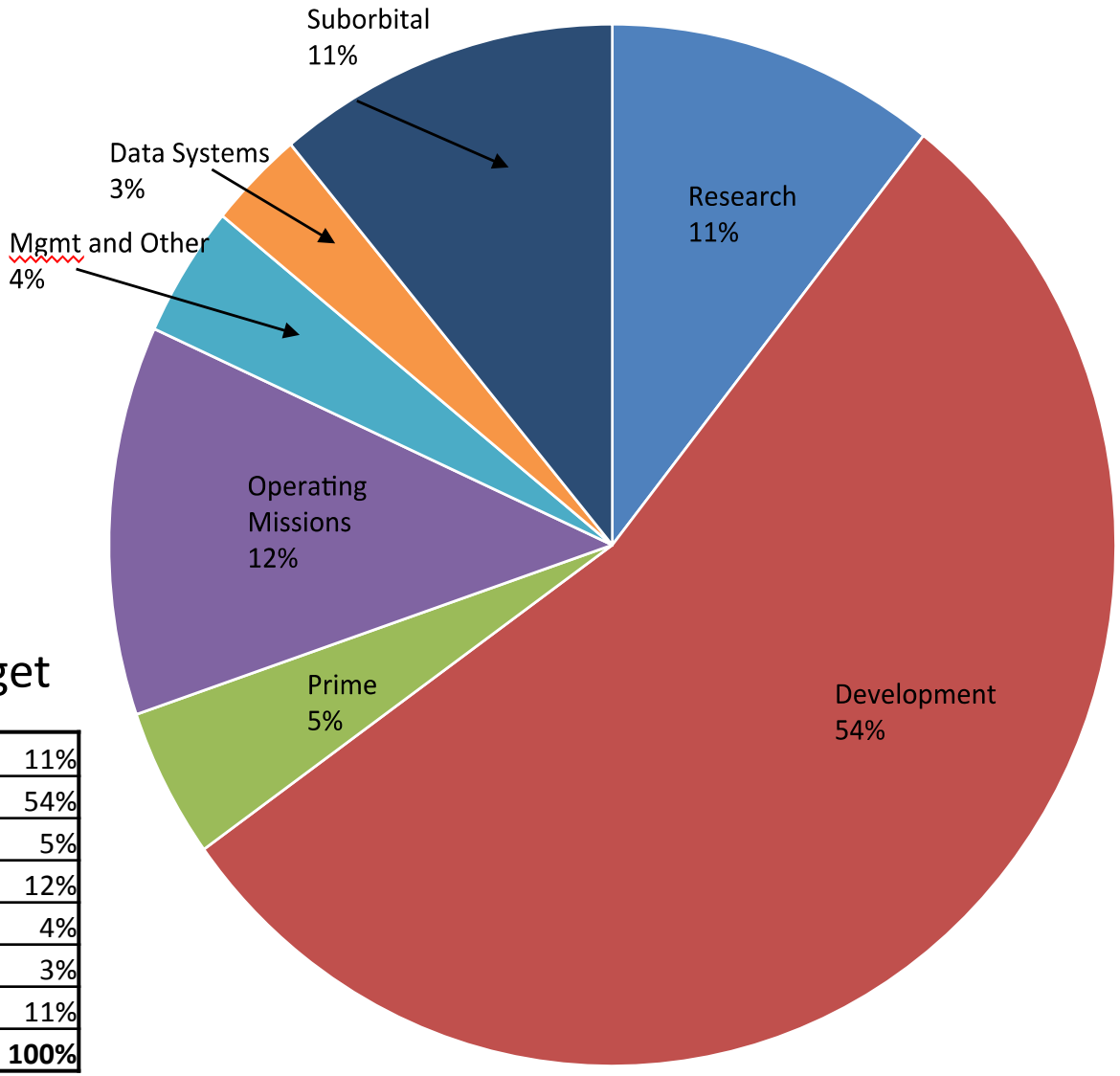
Steven W. Clarke, Heliophysics Division Director

Update Topics

- **Budget**
- **Mission**
- **Research & Analysis**
- **International Partnerships**
- **FACA**
- **Division Assignment Changes**

Budget Update

Heliophysics Budget



FY2016 Heliophysics Budget

Research	68,658	11%
Development	352,466	54%
Prime(MMS)	30,138	5%
Operating Missions	78,170	12%
Management and Other	26,424	4%
Data Systems	19,890	3%
Suborbital	71,420	11%
Total	**647,166**	**100%**

Heliophysics Budget

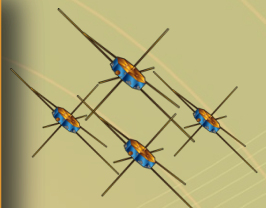
$M	FY15	FY16 Enacted	FY17	FY18	FY19	FY20	FY21
Heliophysics	636.1	647.2	698.7	684.0	698.3	714.8	723.9

- Missions in development fully funded
  - Space Environments Testbed-1 (SET-1) – NET September 2017
  - Ionospheric CONnection Explorer (ICON) – October 2017
  - Global Observation of the Limb and Disk (GOLD) – April 2018
  - Solar Probe Plus (SPP) – July 2018
  - Solar Orbiter Collaboration (SOC) – October 2018
- Future mission funding
  - ✓ Release Explorer mission AO/MO in FY16
  - Release STP-5 (IMAP) mission AO/MO in FY17
  - Release LWS-7 (GDC) mission AO/MO in FY18
- OMB Mandatory Spending (FY2017 only):
  - +$10.0M for Heliophysics/Cubesat program
  - +$10.0M for Heliophysics/Space weather research in support of the Space Weather Action Plan
  - +$5.0M for Research & Analysis

Mission Update

Heliophysics Program 2015-2024

Solar Terrestrial Probes

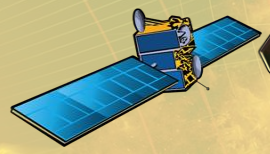


Magnetospheric Multiscale (MMS) March 2015

Interstellar Mapping Probe (IMAP) (STP #5) 2023*

Heliophysics MO 2023*

Living With a Star

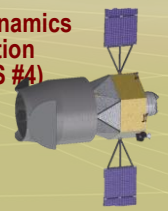


Space Environment Testbeds (SET) NET September 2017

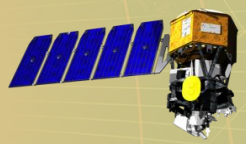
Solar Probe Plus July 2018

Solar Orbiter Collaboration (with ESA) October 2018

Geospace Dynamics Constellation (GDC)(LWS #4) 2024*

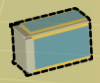


Explorers



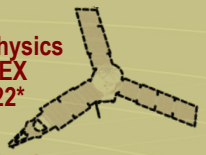
Ionospheric Connection Explorer (ICON) October 2017

Global-scale Observations of the Limb and Disk (GOLD) April 2018



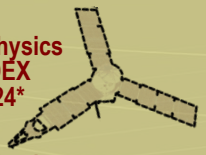
Heliophysics MO 2020*

Heliophysics SMEX 2022*



Heliophysics MO 2022*

Heliophysics MIDEX 2024*



Heliophysics MO 2024*

Research Program

Solar/Heliospheric: November 2016
Solar/Heliospheric – December 2016
Solar/Heliospheric – December (tbd) 2016

Ongoing

Heliophysics Missions
Astrophysics Missions
Planetary Missions

2015 2016 2017 2018 2019 2020 2021 2022 2023 2024

*Notional

Mission Suite

Mission	Launch	Phase	Extension to (*)	M-3	M-2	M-1	Cur. M.	Remarks
Geotail	7/24/1992	Extended	12/31/2016					
STEREO	10/25/2006	Extended	9/30/2018					STEREO-B contacted (8/21) and recovery under way.
THEMIS+Artemis	2/17/2007	Extended	9/30/2018					on 9/2, 9/4 & 9/5 D experienced 4 BAU cold reset anomalies: 10 hr loss
AIM	4/25/2007	Extended	9/30/2018					on 9/2 undervoltage due to lunar transit. S/C in safemode.
Hinode	9/23/2006	Extended	9/30/2018					
ACE	8/27/1997	Extended	9/30/2018					
RHESSI	2/5/2002	Extended	9/30/2018					
SOHO	12/2/1995	Extended	9/30/2018					
TIMED	12/7/2001	Extended	9/30/2018					
Voyager 1 + 2	8/20/1977	Extended	9/30/2018					
TWINS A + B	6/2006 & 3/2008	Extended	9/30/2018					
IBEX	10/19/2008	Extended	9/30/2018					on 9/1 the Flight Comp had a reboot: recovered 9/4. SEU likely
Wind	11/1/1994	Extended	9/30/2018					
SDO	2/11/2010	Extended	9/30/2018					
Van Allen	8/30/2012	Extended	9/30/2018					
IRIS	6/27/2013	Extended	9/30/2018					
MMS	3/12/2015	Prime	9/1/2017					maneuvers performed on 8/31 & 9/1, resizing from 40 km to 10 km.

(*) Extended mission end dates subject to upcoming Senior Revie (+) Terminates at date.

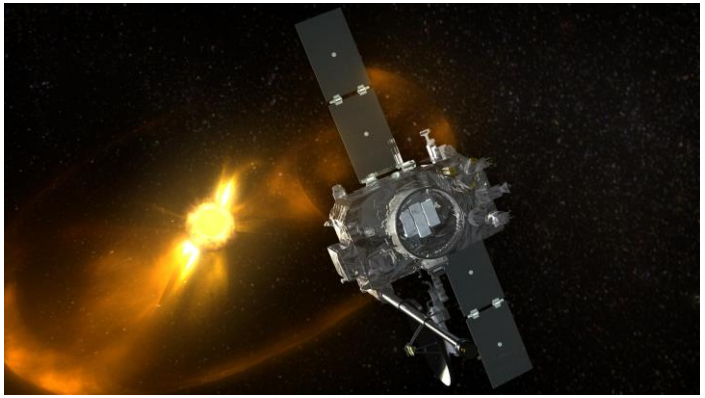
Mission proceeding to meet science requirements

Area of concern - possible reduction in capability

Significant problem – possible or probable loss of mission

STEREO B Recovery Attempt Status

- First contact was made on 20 August 2016
- Declared spacecraft emergency and had repeated contacts over the next two weeks
  - Ascertain Spacecraft status
  - Disable autonomy
  - Charge Battery – Partially damaged (2 cells) – max volts ~26V
  - Warm up propulsion system
- Attempted autonomous recovery on 7 September 2016
  - Propulsion system warm – no pressure however
  - Battery charged sufficiently
  - Bad gyro's masked
  - Results
    - Spacecraft reset, autonomy rules fired, ST locked, momentum dump attempted
    - Momentum decreased some but not as much as expected – 2 wheels saturated
    - Did not regain attitude control or end up continuously power positive.
    - Intermittent contact; Attempts will continue to mitigate further spacecraft degradation



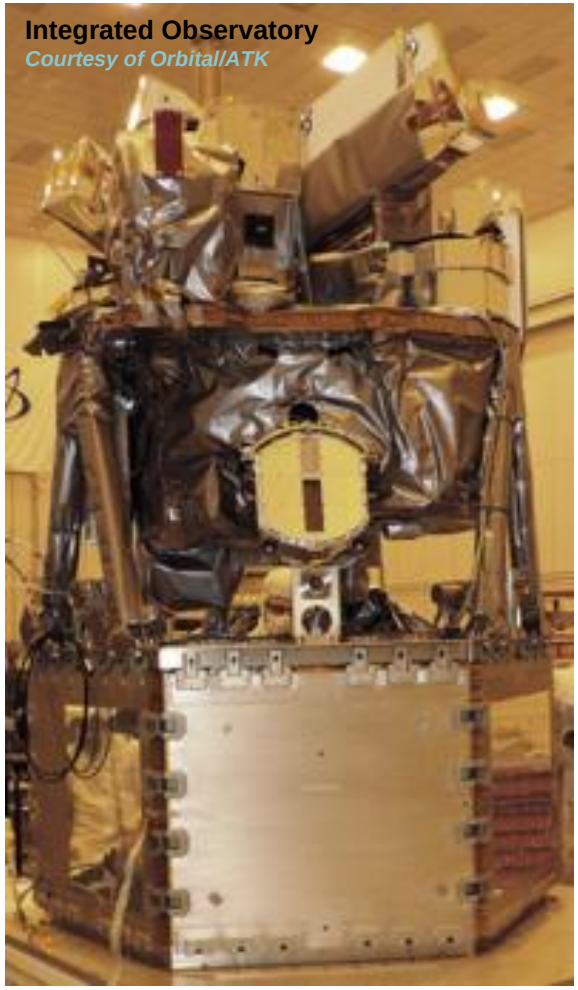
Current orientation supports some solar array input, RF communications only supports uplink of short commands to an LGA. The battery charge rate is C/10 and voltage controller to 12. Power switching boards are on, nearly all switched loads off. The TWTA is in standby, IEM (avionics), PDU 1553 bus, and propulsion tank primary heaters are on. EA mode is enabled.

Recovery attempts will continue until mid-October when BEHIND will start moving into an unfavorable alignment on getting sunlight onto the solar panels. It is anticipated that we will continue monthly contacts until June of 2017. At that point we will suspend attempts until the summer of 2020, when the alignment becomes more favorable.

ICON
- Ionospheric Connection -

Recent Accomplishments:

- Payload lift and mechanical mate completed.
- Integration of payload completed successfully
- Orbital Debris Assessment Report and waiver have been approved through HQ OSMA and in signature cycle at SMD.
- Completed KDP-D DPMC on 26 August.



Upcoming Milestones/Events:

- Observatory PER – TBD Oct 2016
- Observatory PreShip Review – 27 Feb 2017
- LRD – October 2017

Issues/Concerns:

- ICON Master Avionics Unit (IMAU) failure during Comprehensive Performance Testing is under investigation.

GOLD
- Global Observations of the Limb And Disk -

Recent Accomplishments:

- Successfully completed all environmental testing

Ongoing:

- Post-Environmental calibration of both channels

Future Activities:

- Packaging and shipment
- Final operational tests with spacecraft

Upcoming Milestones/Events:

- Pre-Ship Review – 29 November 2016
- Instrument delivery to Airbus – NLT 15 January 2017
- Launch Readiness Date - April 2018

Issues/Concerns:

- None

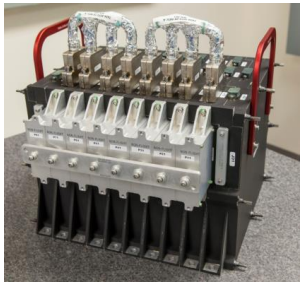
GOLD Penalty Vibration Testing Complete

SPP
- Solar Probe Plus -

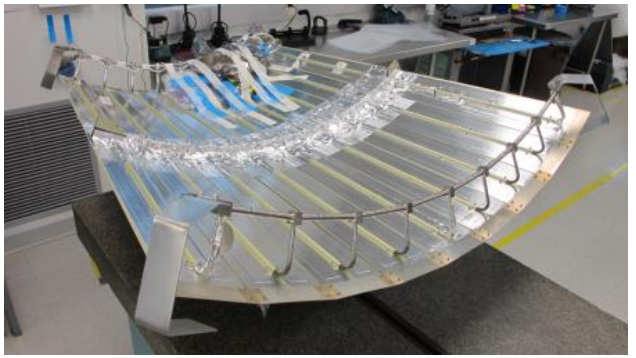
Recent Accomplishments

- Integration and testing ongoing at APL
  - Flight Model Power System Electronics (PSE) successfully integrated onto the spacecraft
    - power-up, commanding and telemetry receipt successful
  - Completed electrical integration of the Flight Model Radios
    - Commanding and telemetry receipt from Flight Radio A and B successful

Flight PDU integrated on S/C



FM Power Distribution Unit testing complete – Ready for S/C Integration



Solar Array Cooling System Radiator 1

Upcoming Milestones/Events

- PER: 6 October 2017
- PSR: 8 March 2018
- LRD: 31 July 2018

Issues/Concerns

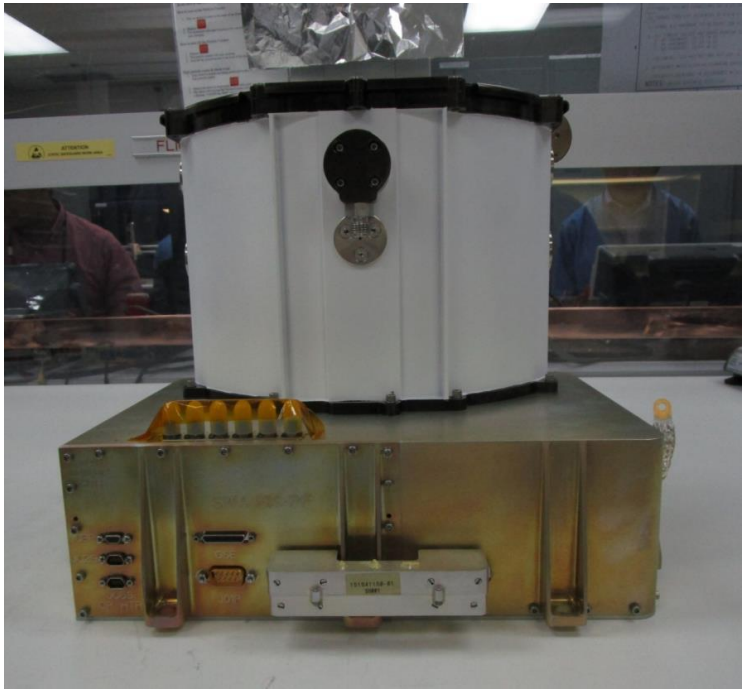
- Potential delay in SWEAP instrument delivery due to Smithsonian Astrophysics Observatory (SAO) critical skills risk

SOC
- Solar Orbiter Collaboration -

Recent Accomplishments:

- Heavy Ion Sensor (HIS) instrument Detector Section (DS) was successfully integrated with the flight Main Electronics Box (MEB).
- Vibration test readiness review for the Solar Orbiter Heliospheric Imager (SoloHI) is complete.

Flight Model MEB to
DS-Time of Flight Integration



Upcoming Milestones/Events:

• HIS PER	18 October 2016
• SoloHI PSR	6 November 2016
• HIS PSR	4 January 2017

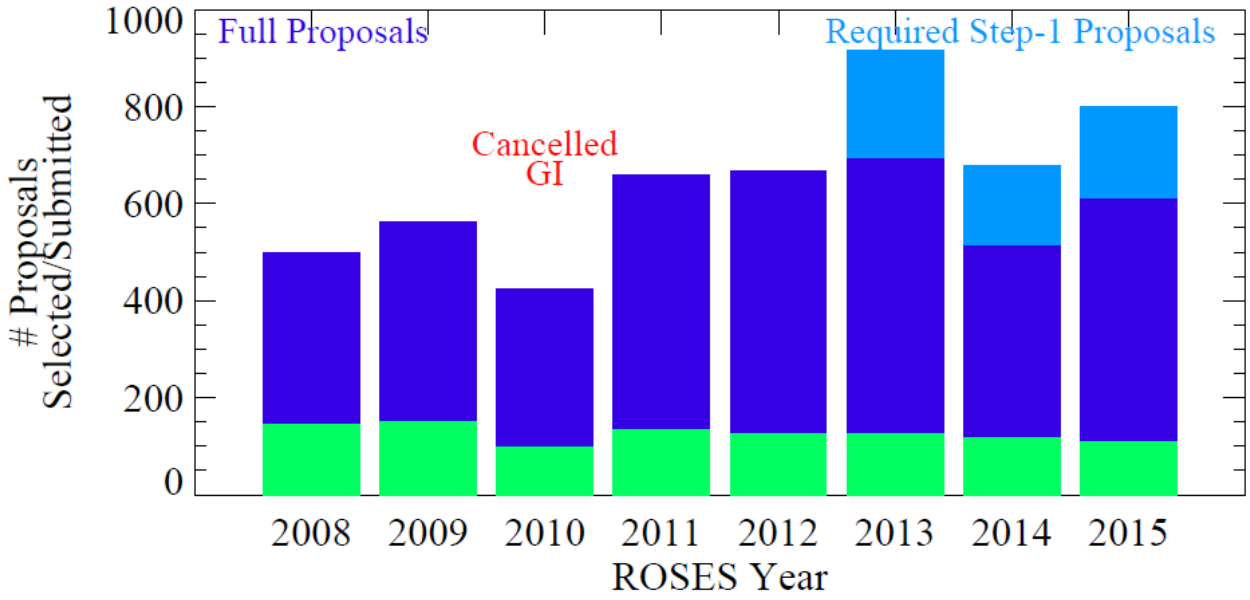
Issues/Concerns:

- ESA Mission Delta-CDR action item closeout has been delayed to mid-October (one month slip).

Research & Analysis

HPD 2015 ROSES Complete

ELEMENT	STEP 1 PROPOSALS	STEP 2 PROPOSALS	AWARDS	YEAR 1 ($M)
B.2 H-SR	343	251	46	5.5
B.3 H-TIDeS	135	106	12	4.7
B.4 H-GI	204	149	22	2.9
B.6 H-LWS	103	92	20	3.5
B.7 H-IDEE	15	14	8	0.5
TOTALS	**799**	**612**	**108**	**17.1**



ROSES15 Average Success Rate (vs. Full Proposals): 18%

HPD 2016 ROSES Status

ELEMENT	STEP 1 PROPOSALS (Due Date)	STEP 2 PROPOSALS (Due Date)	AWARDS (Expected)	YEAR 1 ($M)
B.2 H-SR	**235**	**212**	(17-20)	($4M)
B.3 H-TIDeS	**87**	**71**	(12)	($4.75M)
B.4 H-GI Open	**197**	**181**	**33**	**$3.0M**
B.5 H-GCR TMS	- (10/13)	- (11/18)	(8-10)	($4M)
B.6 H-LWS	- (10/7)	- (11/18)	(15-20)	($3.75M)
B.7 H-DEE	**28**	**24**	(10-12)	($1M)
B.8 H-GI MMS	- (Nov.)	- (Jan.)	(TBD)	(TBD)
B.9 H-GCR SC	*PPD ROSES17*	*PPD ROSES17*	-	-
B.10 H-USPI	**7**	- (10/14)	(2)	($0.4M)
E.5 ISE	(10/28)	(11/30)	(12)	(0.8M)

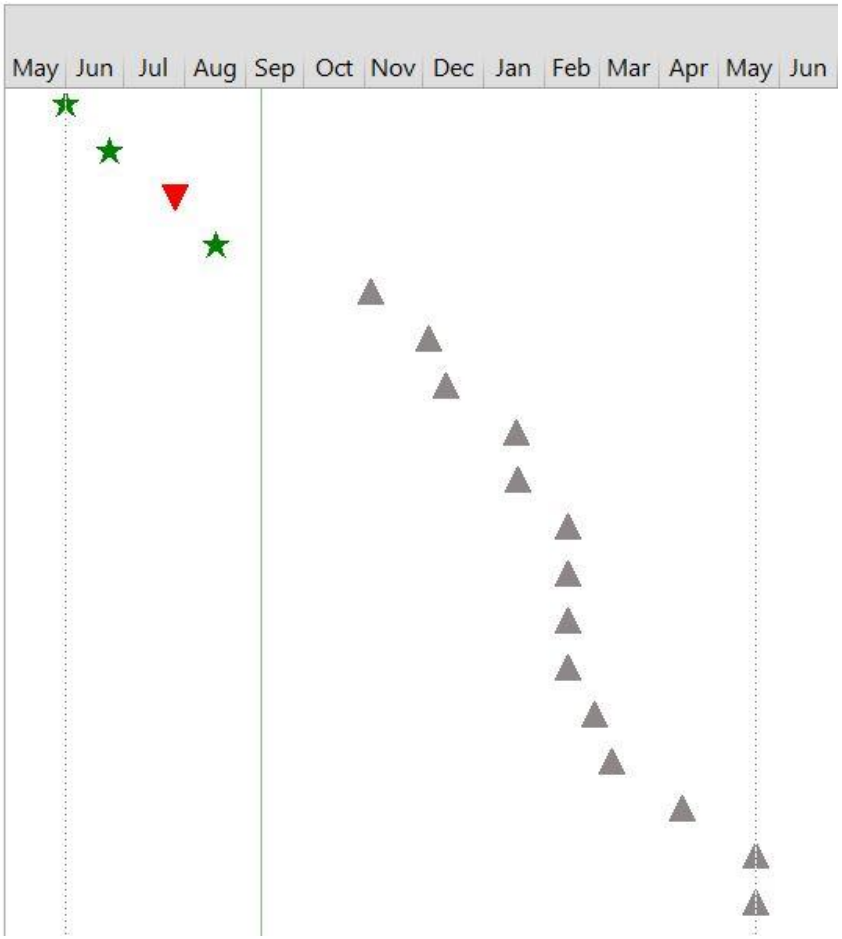
Total Solar Eclipse 2017
NASA Research Announcement (NRA)

- NASA Research Announcement (NRA) for the total solar eclipse in August 2017 released on 28 September
- Primary purpose of NRA is to support development of new research or enhancement of existing research applied to the 2017 eclipse
- Building on existing partnerships and the use of interdisciplinary or citizen science approaches is encouraged
- Proposals must demonstrate links to the 2017 solar eclipse
- Two-step proposal process
  - Step-1 proposals due 27 October
  - Step-2 proposals due 30 November
- Total award value is approximately $0.8M (Heliophysics); ***may*** be supplemented by other SMD Divisions if applicable proposals are received and panel recommends award

Sounding Rockets Schedule

Mission Manifest: June 2016 – May 2017

Mission Title	Launch Date
WOODS SDO-EVE @ WS	Wed 6/1/16
KOEHLER ROCKON-RockSAT-C @ WI	Fri 6/24/16
CIRTAIN HiC @ WS	Wed 7/27/16
KOEHLER RockSAT-X @ WI	Wed 8/17/16
HASSLER RAISE @ WS	Fri 11/4/16
CHRISLEY ZOMBIE @ WS	Sun 12/4/16
HESH SUBTEC 7 @ WI	Tue 12/13/16
LARSEN AZURE @ FB	Wed 1/18/17
BAILEY POLARNOX @ FB	Thu 1/19/17
PFAFF JETS @ FB	Mon 2/13/17
LYNCH ISINGLASS @ FB	Mon 2/13/17
LYNCH ISINGLASS @ FB	Mon 2/13/17
PFAFF JETS @ FB	Mon 2/13/17
MILLINER @ WI	Mon 2/27/17
TUN HERSCHEL @ WS	Wed 3/8/17
HALL @ WI	Thu 4/13/17
CHRISLEY ZOMBIE @ WS	Sat 5/20/17
CHRISLEY ZOMBIE @ WS	Sat 5/20/17



International Partnerships Update

International Collaboration Update

- Korea Astronomy and Space Science Institute (KASI)
  - First working group meeting held at NASA HQ on 21 September
  - Potential near-term collaboration topics discussed

- NASA/Japan Aerospace Exploration Agency (JAXA)/European Space Agency (ESA)
  - Multilateral science objectives team (SOT) established to study the next generation solar physics mission using the Solar-C concept as point of departure
  - 3 co-chairs (NASA, JAXA, ESA)
  - 12 members from the US, Japan and Europe (4 each)
  - Call for community input to science objectives released
  - Draft report due in 9 months (April 2017); final report due in July 2017
- Indian Space Research Organisation (ISRO)
  - Working group charter approved by NASA and ISRO
  - Kickoff meeting to be scheduled

Federal Advisory Committee Act (FACA)

Evolution of the Heliophysics Subcommittee

- NASA has decided to apply for FACA charters for the four science advisory subcommittees, including the Heliophysics Subcommittee.
- Many community-based studies (e.g., Senior Reviews, Science and Technology Definition Teams) require a chartered Federal Advisory Committee to which to report.
- Once chartered, this Heliophysics Subcommittee (HPS) will be replaced by the Heliophysics Advisory Committee (HPAC).
  - All current HPS members will be appointed to the HPAC.
  - Meeting schedule and member expectations will be unchanged.
- The Heliophysics Advisory Committee will report to the Director of the Heliophysics Division.
- The HPAC Chair will continue to serve as a member of the NAC Science Committee.
- Once the Heliophysics Advisory Committee is chartered, then the Director of the Heliophysics Division will establish subordinate groups, such as:
  - Senior Reviews
  - Future Science and Technology Definition Teams (STDT) (e.g., GDC)

Division Assignment Updates

Heliophysics Division - Science Mission Directorate

21 July 2016

Director
Steve Clarke

Deputy Director
Peg Luce

Resource Management
Ralph Beaty[+]
Jennifer Holt[+]

Chief Scientist – *Vacant*

Secretary: *Gloria Stewart*
Admin Asst: *Aaluk Edwardson**
Program Support Specialist: *Jackie Mackall*

Cross Cutting

Education Lead: *Lika Guhathakurta*
Career Enhancement for New Technologists and Scientists (CENTS): *Liz MacDonald**
Division Public Affairs: *Dwayne Brown*
Emerging Partnerships Manager: *Lika Guhathakurta*
Space Weather Lead: *Elsayed Talaat*
Chief Technologist: *Dan Moses*
- SMD Cubesat Implementation Program (SCIP)

Policy Analyst: *Mariel Borowitz/Becky McCauley Rench* [+]
Interagency/International Relations: *Jake Parsley*

Heliophysics Research

Program Manager: *Arik Posner*

Program Support*: Guan Le, Terry Kucera, EJ Summerlin*, Katya Verner**

Grand Challenge (GCR): *Mona Kessel*

- *Lika Guhathakurta – Heliophysics Science Centers*

Guest Investigator (GI): *EJ Summerlin**

Infrastructure & Data Environment Enhancements (IDEE): *Jeff Hayes*

Supporting Research (SR): *Arik Posner (SH)/Elsayed Talaat (Mag/ITM)*

TIDeS: *Dan Moses/Liz MacDonald* (Deputy Program Scientist)*

[+] *Member of the Resources Mgmt Division or Strategic Integration and Mgmt Division*
* *Detailee, IPA, or contractor*

Programs / Missions

	Program Scientist	Program Executive
Living With a Star (LWS)		
Program	***Elsayed Talaat***	***Joe Smith***
Science	***Jeff Morrill****	
SET	TBD	*Alan Zide**
SOC	*Jeff Morrill**	*Joe Smith/Alan Zide**
SPP	*Elsayed Talaat*	*Joe Smith*
Solar Terrestrial Probes (STP)		
Program	***Mona Kessel***	***Bill Stabnow***
IMAP	*Arik Posner*	*Joe Smith*
Explorers		
Program	***Dan Moses***	***Willis Jenkins***
ICON	*Jeff Morrill**	*Willis Jenkins*
GOLD	*Elsayed Talaat*	*Bill Stabnow*
EXP-XX	*TBD*	*TBD*
Sounding Rockets & Range		
Program	***Dan Moses***	***George Albright***
	Deputy PS: Liz MacDonald*	
Operating Missions		***Jeff Hayes***
ACE	*Arik Posner*	
AIM	*Elsayed Talaat*	
Geotail	*Mona Kessel*	
Hinode	*TBD*	
IBEX	*Arik Posner*	
IRIS	*Lika Guhathakurta*	
MMS	*Mona Kessel*	
RHESSI	*TBD*	
SDO	*Lika Guhathakurta*	
SOHO	*Lika Guhathakurta*	
STEREO	*Lika Guhathakurta*	
THEMIS	*Elsayed Talaat*	
TIMED	*Elsayed Talaat*	
TWINS	*Mona Kessel*	
Van Allen	*Mona Kessel*	
Voyager 1 & 2	*Arik Posner*	
Wind	*Arik Posner*	

- ***PS – Vacancy***
- ***PE - Vacancy***

Blue – In Development
Green – Pre-Formulation

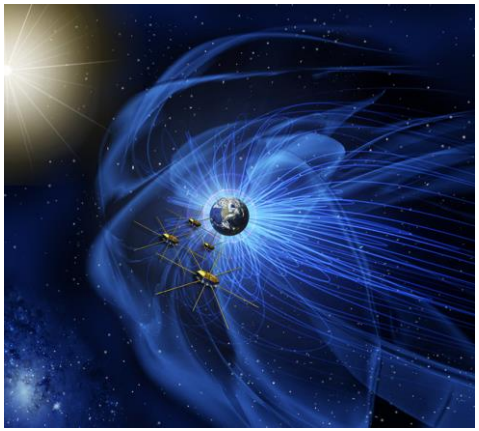
Thank You

Backup

Heliophysics Science Highlights: September 2016

New Advances in Magnetic Reconnection at the electron-scale level using Heliophysics MMS Data

Burch, J. L., and T. D. Phan (2016). MAGNETIC RECONNECTION AT THE DAYSIDE MAGNETOPAUSE: ADVANCES WITH MMS. *Geophysical Research Letters:* 43, 8327–8338. doi:10.1002/2016GL069787



Artist's rendering of the four spacecraft MMS mission. Credit: NASA

- Dr. Jim Burch, the PI for MMS, and Dr. Tai Phan, a Senior Fellow with the Space Sciences Laboratory, recently published a paper in the *Geophysical Research Letters* using Magnetospheric Multi-Scale mission data to introduce a new magnetic reconnection event near an X-line of a reconnecting magnetopause region.
- Past experimental efforts have advanced our understanding of ion-scale physics, but more data on the electron-scale processes that cause magnetic reconnection is needed.
- This December 2015 event occurred in the dayside magnetopause, the boundary region between Earth's magnetosphere and the solar wind.
- The two magnetic fields involved in this event were at an angle near 45°, creating strong antiparallel components in the plane of reconnection.
- There was also an out-of-plane magnetic field component, which is known as the guide field. The effects of a guide field on magnetic reconnection has been an active topic of theoretical research.
- A second scan of the dayside magnetopause will begin this month, September 2016. A study of more events is needed to further understand magnetic reconnection at this electron-scale level.

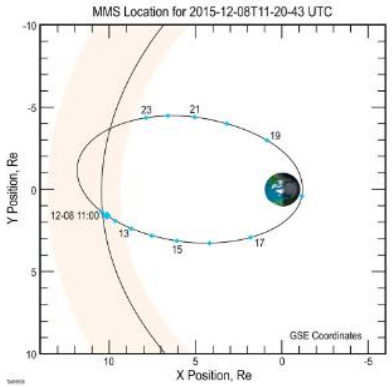
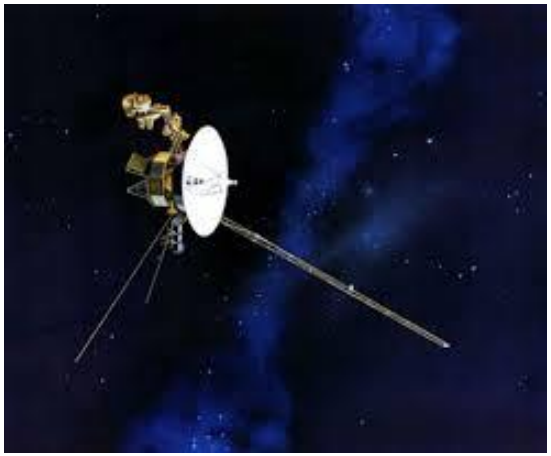


Figure: GSE equatorial-plane projection of MMS orbit on December 8, 2015 with UT hours noted. During 3-second interval MMS encountered an electron diffusion region (EDR) near the X-line of a magnetopause reconnection event. Credit: Burch, et al

Heliophysics Science Highlights: September 2016

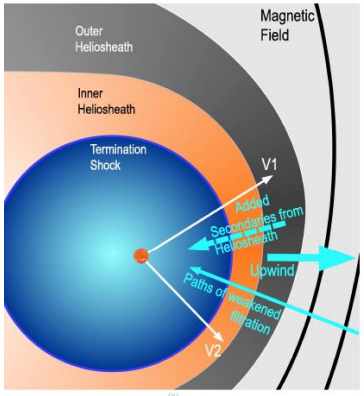
Heliophysics IBEX Mission Delivers Important Data on our Boundary with Interstellar Space to our Doorstep

Schwadron , et al. (2016). DETERMINATION OF INTERSTELLAR O PARAMETERS USING THE FIRST 2 YEARS OF DATA FROM THE INTERSTELLAR BOUNDARY EXPLORER. Astrophysical Journal (in press)



- The NASA Heliophysics Interstellar Boundary Explorer (IBEX) mission, launched in 2008, measures particles at the heliopause to better understand this boundary and in which direction our solar system is traveling through space.
- Asymmetries along the boundary, and the changing activity of the sun, affect the flow of galactic cosmic radiation into our solar system. Understanding more about these asymmetries is important as this radiation has the potential to impact Earth's atmospheric layers and pose hazards to human space exploration.

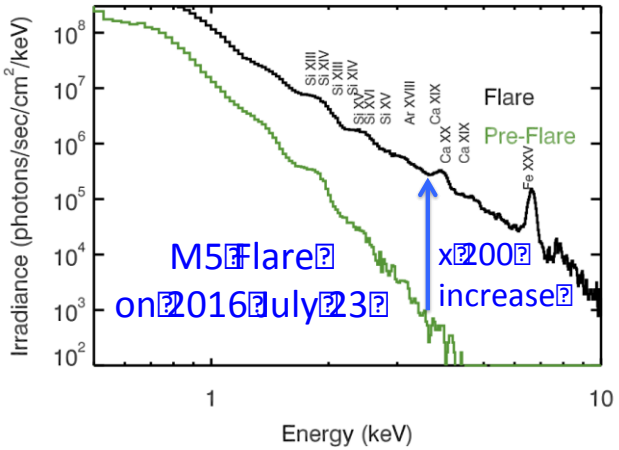
- In a paper soon to be published in the *Astrophysical Journal,* Dr. Nathan Schwadron of the University of New Hampshire and an international team of co-authors confirm a suspected asymmetry at the nose of the heliosphere, which is the area containing our solar system, the solar wind and the entire solar magnetic field.
- The data on Interstellar Oxygen nearly "tricked" scientists into thinking that the heliosphere was traveling more southward than it really is; combining this data with data on Interstellar Helium in this area scientists were able to see a more accurate picture.



This figure shows magnetic fields compressing the nose region of the heliosphere in the south. Credit: IBEX

Heliophysics Science Highlights: Septemeber 2016

MinXSS CubeSat Fills Important Spectral Gap in Solar Irradiance Measurements



This is a MinXSS measurement of the M5.0 flare taken on July 23, 2016 and indicates a factor of 200 increase in the brightness of soft X-ray (SXR) emissions. The pre-flare spectrum is the green line, and the flare spectrum is the black line. Some of the brighter coronal emissions lines are also labeled. Credit: MinXSS

- MinXSS, the first CubeSat ever launched for the Science Mission Directorate, has been collecting data since its deployment from the International Space Station on May 16th of this year.
- MinXSS data fills an important spectral gap in solar irradiance measurements, collecting soft X-ray (SXR) data at spectral resolutions we haven't obtained before.
- By July, it had already met its minimum mission science criteria for science data and observations, seeing over 7 M-class solar flares and over 40 C-class flares.
- The minimum mission science criteria for MinXSS is to collect measurements of solar full-disk irradiance in SXR with a spectral resolution better than 1 nanometer, to sustain 30% accuracy for a minimum of one month, and to observe at least 6 medium-sized flares.
- MinXSS also won the 2016 AIAA Small Satellite Mission of the Year Award in August.

Student Outreach RockSat-X Launched with Interesting Student Payloads Last Month

- The sixth flight of a RockSat-X education payload launched on a suborbital Rocket from the Wallops Flight Facility in Virginia last month.
- RockSat-X is an educational mission, providing students with an opportunity to learn from and engage in the process of building experiments for a scientific payload.
- The payload consisted of a broad range of interesting student-developed experiments from eleven different colleges.
- Although the payload was lost, the mission itself was an educational success for the students and the program. Some data was received through telemetry.

Students celebrating the successful launch. Credit: NASA Wallops