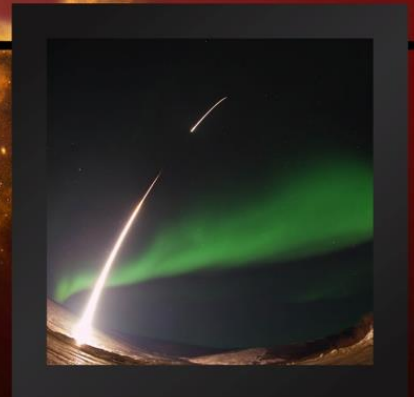
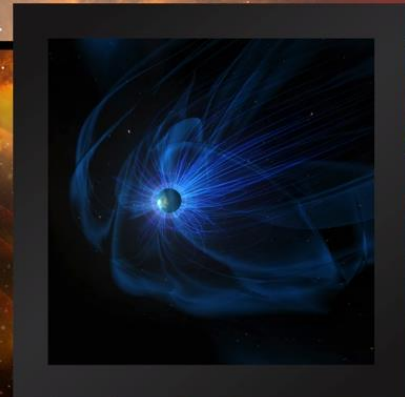


HELIOPHYSICS DIVISION



*Heliophysics Division Update
NAC Science Committee Meeting
November 2, 2015
Steven W. Clarke, Director*



Update Topics



- **Science Highlights**
- **Senior Review Results**
- **Missions in Development**
- **Sounding Rockets**
- **Research & Analysis**
- **National Space Weather Strategy**
- **Division Strategy**



Science Highlights



Heliophysics Science Highlights

September 2015

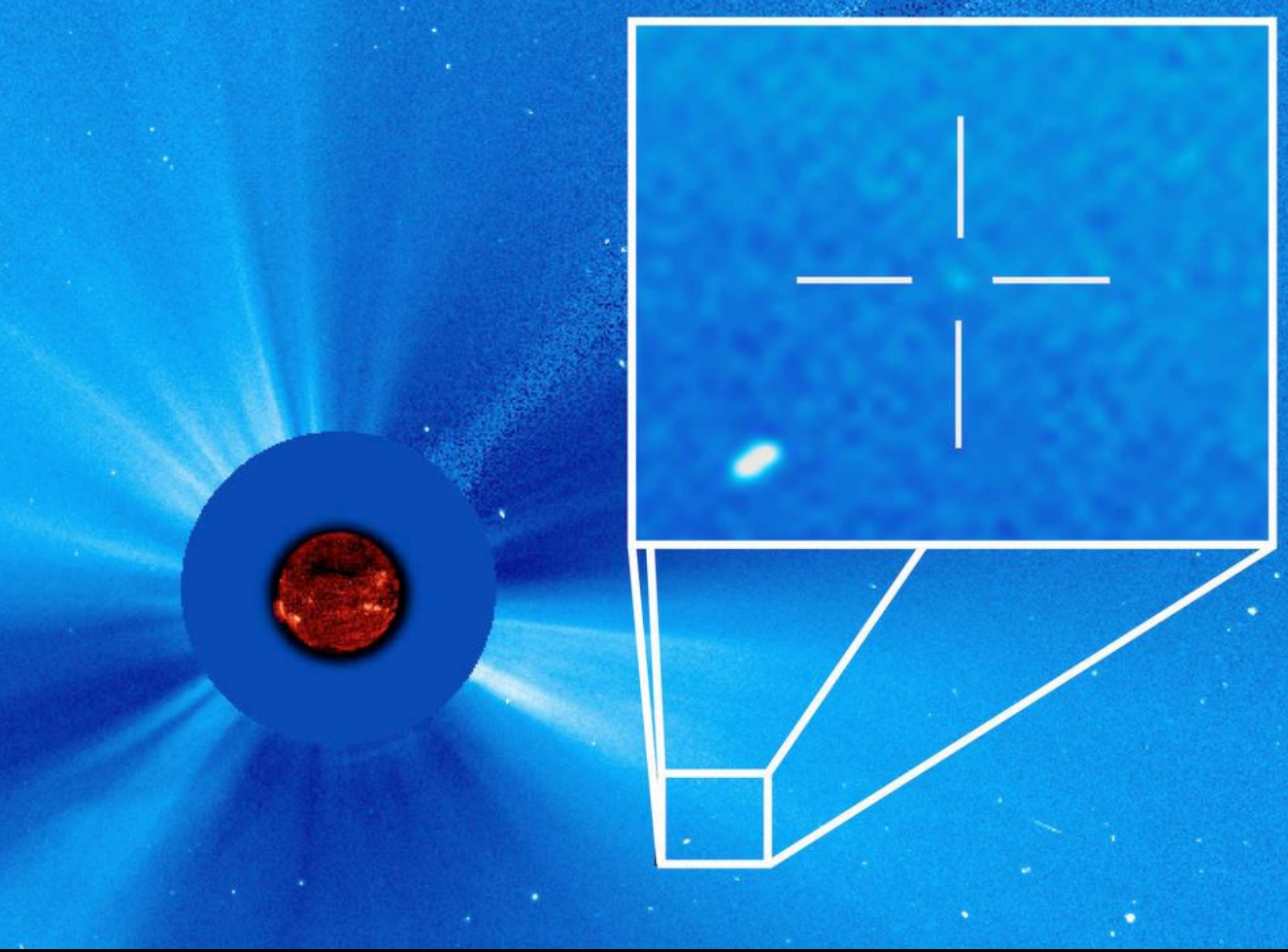


SOHO Discovers Its 3,000th Comet!

- On Sept. 13, 2015, citizen scientist Worachate Boonplod, of Samut Songkhram, Thailand used data from the Solar and Heliospheric Observatory (SOHO) to discover its 3,000th comet.

- Prior to the 1995 launch of SOHO, only a dozen or so comets had ever even been discovered from space, while some 900 had been discovered from the ground.

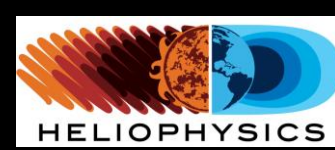
- SOHO's great success as a comet finder is dependent on the people who sift through its data – a task open to the world as the data is publicly available online in near-real time. The result: 95 percent of SOHO comets have been found by these citizen scientists.





Heliophysics Science Highlights

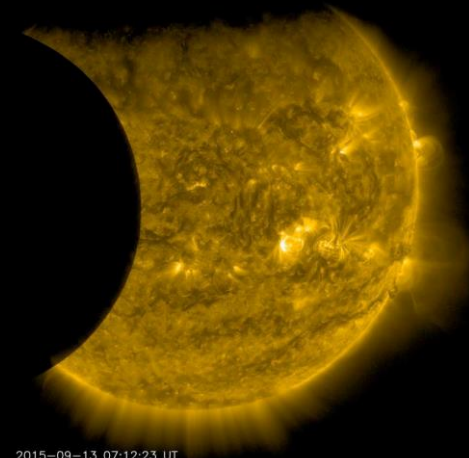
September 2015



NASA's BARREL Team Return from Sweden: After seven balloon launches in the bright Arctic sun, the BARREL team has returned home from a 4-week campaign in Kiruna, Sweden, north of the Arctic Circle. Each research balloon observed emissions high in our atmosphere that correlated to events in the complex space environment above. This third mini-balloon campaign follows two 20-balloon campaigns that launched from Antarctica in 2013 and 2014. The team also achieved science conjunction with six other missions during this campaign, collecting data in coordination with NASA's Van Allen Probes, MMS, THEMIS, the joint ESA/NASA Cluster and two CubeSat missions.

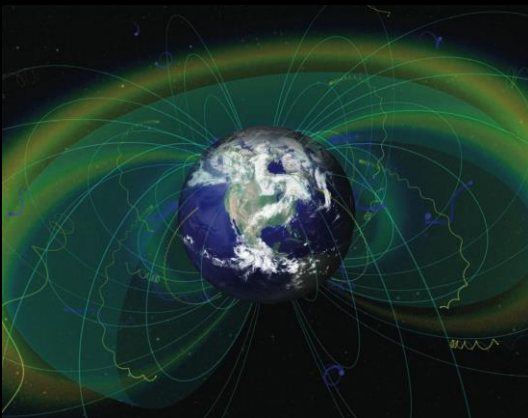
SDO Observes an Earth Eclipse and a Lunar Transit in the Same Day!:

On Sept. 13, 2015, as NASA's Solar Dynamics Observatory, or SDO, kept up its constant watch on the sun, its view was photo-bombed not once, but twice. Just as the moon came into SDO's field of view on a path to cross the sun, Earth entered the picture, blocking SDO's view completely. When SDO's view of the sun emerged from Earth's shadow, the moon was just completing its journey across the sun's face.



SDO/AIA 171 2015-09-13 07:12:23 UT

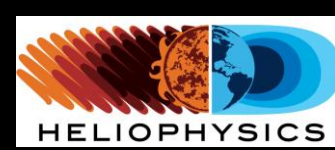
Van Allen Probes Celebrate Third Anniversary of Launch: On Aug. 30, three years after NASA's Van Allen Probes were launched, the twin spacecraft continue to push the boundaries of what is known about the space above our world. These discoveries have led to the formulation of new objectives for the extended mission including optimized data compression and a new maneuver to double the number of times the spacecraft lap each other, allowing scientists to gather more detailed information on the processes that accelerate radiation belt particles.



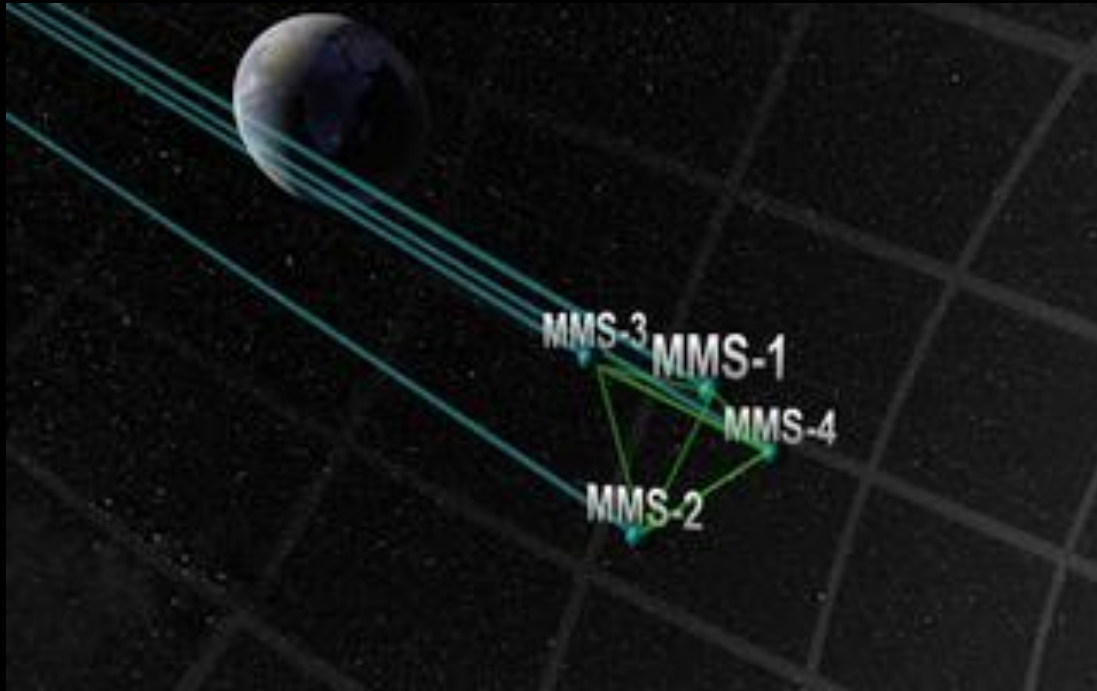


Heliophysics Science Highlights

October 2015



MMS Spacecraft Achieve Tightest Flying Formation Ever!



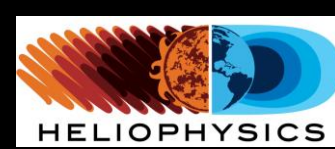
- On Oct. 15, 2015, a NASA mission broke its own record: the four satellites of its Magnetospheric Multiscale (MMS) mission are now flying at their smallest separation, the tightest multi-spacecraft formation ever flown in orbit. The four spacecraft are just six miles apart, flying in what's called a tetrahedral formation, with each spacecraft at the tip of a four-sided pyramid. The close formation is all the more impressive as the spacecraft speed along at up to 15,000 miles per hour and – with their booms extended – each spacecraft covers as much area as a professional baseball stadium.

When MMS first formed a tetrahedral shape in July 2015, the spacecraft were flying about 100 miles apart. Over the past few months, MMS gradually closed that spacing to just six miles. Another mission, ESA/NASA's Cluster, had times in which two of its four spacecraft were that close, but MMS is the first mission to hold four spacecraft in such close proximity. To achieve this milestone, first the MMS spacecraft dropped down to 40 miles apart, then 15 and finally on Oct. 15 the spacing dropped to its closest point, just a little over six miles apart. After operating over that range, the MMS science team will then decide what spacing was optimal and return to that value.



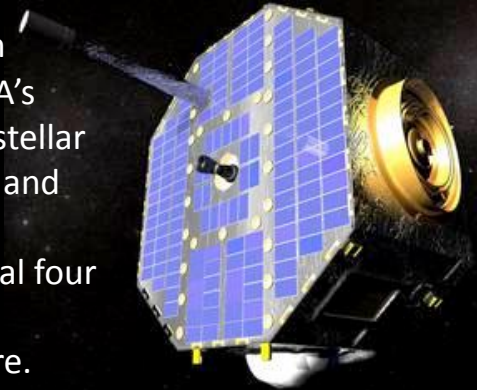
Heliophysics Science Highlights

October 2015



Measuring the Pulsating Aurora: Scientists compared ground-based data of pulsating auroras—a certain type of aurora that appears as patches of brightness regularly flickering on and off—with satellite measurements of the numbers and energies of electrons raining down towards the surface from inside Earth’s magnetosphere. The team found something unexpected: A drop in the number of low-energy electrons, long thought to have little or no effect, corresponds with especially fast changes in the shape and structure of pulsating auroras.

IBEX Sheds New Light on Solar System Boundary: In 14 papers published in the October 2015 Astrophysical Journal Supplement, scientists present findings from NASA’s IBEX mission providing the most definitive analyses, theories and results about local interstellar space to date. Eight papers highlight the interstellar helium measurements taken by IBEX and the joint European Space Agency and NASA Ulysses spacecraft. Two papers examine determining the composition of interstellar particles and how they are measured. The final four papers discuss analysis techniques and related theoretical considerations, such as how planetary gravity affects the course of neutral atoms as they travel through the heliosphere.



Comet Encke: A Solar Windsock Observed by NASA’s STEREO:

According to new studies of a comet tail observed by NASA’s STEREO spacecraft, the vacuum of interplanetary space is filled with turbulence and swirling vortices similar to gusts of wind on Earth. Scientists studied the movements of hundreds of dense chunks of glowing ionized gas within the ribbon of Comet Encke’s tail in 2007. Fluctuations in the solar wind are mirrored in what is seen in the tail, so scientists were able to reconstruct the motion of the solar wind. This turbulence can help explain the solar wind's variable nature and its unexpectedly high temperatures.



Senior Review Results





Status of HPD Operating Missions



Mission	Launch	Phase	Extension to (*)	M-3	M-2	M-1	Cur. M.	Remarks
Geotail	7/24/1992	Extended	12/31/2016	Green	Green	Green	Green	
STEREO	10/25/2006	Extended	9/30/2018	Yellow	Yellow	Yellow	Yellow	STEREO-B ping moved to 3/2016 on 10/3 & 10/8 D had SEU; 10.2 hr & 5.5 hr lost resp.
THEMIS+Artemis	2/17/2007	Extended	9/30/2018	Green	Green	Green	Green	
AIM	4/25/2007	Extended	9/30/2018	Green	Green	Green	Green	
Hinode	9/23/2006	Extended	9/30/2018	Green	Green	Green	Green	
ACE	8/27/1997	Extended	9/30/2018	Green	Green	Green	Green	
RHESSI	2/5/2002	Extended	9/30/2018	Green	Green	Green	Green	
SOHO	12/2/1995	Extended	9/30/2018	Green	Green	Green	Green	
TIMED	12/7/2001	Extended	9/30/2018	Green	Green	Green	Green	
Voyager 1 + 2	8/20/1977	Extended	9/30/2018	Green	Green	Green	Green	
TWINS A + B	6/2006 & 3/2008	Extended	9/30/2018	Green	Green	Green	Green	
CINDI:C/NOFS	4/16/2008	Extended	12/31/2015	Green	Green	Green	Green	Reentry of C/NOFS: Nov 2015
IBEX	10/19/2008	Extended	9/30/2018	Green	Green	Green	Green	
Wind	11/1/1994	Extended	9/30/2018	Green	Green	Green	Green	
SDO	2/11/2010	Extended	9/30/2018	Green	Green	Green	Green	
Van Allen	8/30/2012	Extended	9/30/2018	Green	Green	Green	Green	conjunct on 10/4 on A: maneuver not done: miss under 100m.
IRIS	6/27/2013	Extended	9/30/2018	Green	Green	Green	Green	
MMS	3/12/2015	Prime	9/1/2017	Green	Green	Green	Green	

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

 Mission proceeding to meet science requirements

 Area of concern - possible reduction in capability



Mission Rankings



Science Ranking Contribution Ranking

HSO

	Median	Std Dev
IBEX	9	1.6
IRIS	9	1.3
Van Allen	9	1.5
AIM	8	1.2
Hinode	8	1.2
RHESSI	8	1.0
STEREO (2)	8	1.2
TIMED	8	1.2
Voyager	8	1.6
ACE	7	1.5
SDO	7	1.5
STEREO (1)	7	1.4
THEMIS	7	1.8
TWINS	7	1.3
Wind	7	1.2
CINDI	7	1.2

	Median	Std Dev
ACE	9	1.9
SDO	9	1.5
Hinode	9	1.8
IBEX	8	1.2
IRIS	8	1.2
STEREO (2)	8	1.1
THEMIS	8	1.3
Wind	8	1.3
RHESSI	8	1.6
STEREO (1)	8	1.5
Voyager	7	1.6
AIM	7	1.3
TIMED	7	1.9
TWINS	7	1.3
Van Allen	7	1.4
CINDI	6	1.2

All of the missions reviewed by the Senior Review Panel have been recommended for continued operations.



Missions in Development



Recent Accomplishments:

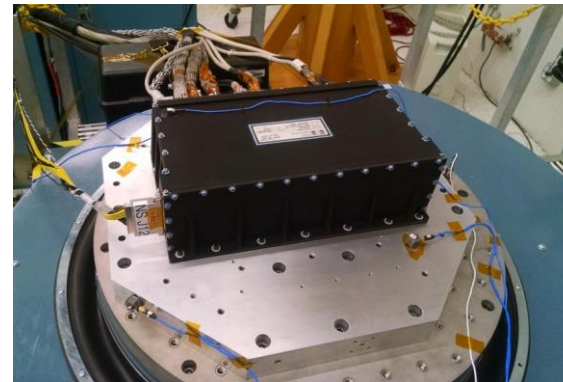
- IMAU: Completed vibration testing; currently in thermal vacuum testing.
- MIGHTI : Flight Model (FM) #1&2 Optical Benches integrated and FM#1 aligned.
- ICP: Data Control Board & Low Voltage Power Supply boards fabricated.
- EUV: Pre-Environmental Review successful; Vibration testing completed.
- FUV: Instrument @ CSL (Belgium).
 - Completed optical alignment testing.
 - Detector potting issue identified requiring process change.
- Solar Arrays completed Test Readiness Review.
- Solar Array Drive Assembly completed Pre-Ship Review.
- Spacecraft integration initiated.

Upcoming Milestones/Events:

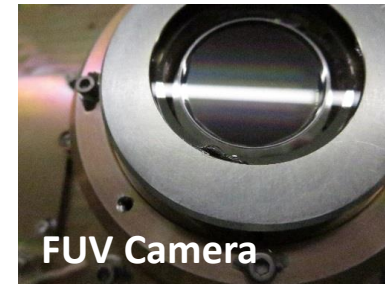
- SIR – June 2016
- KDP-D – July 2016
- PER – August 2016
- LRD – June 2017

Issues/Concerns:

- FUV is now critical path – detector issue resolved



IMAU Vibe Testing



FUV Camera



EUV



- Global Observations of the Limb And Disk -

Recent Accomplishments:

- EM Aperture door mechanism and Lightshade have successfully completed thermal vacuum testing.
- Plating of the Flight Model GOLD Channel housings has been completed.
- Post vibration test pull testing was successfully performed on the kinematic struts.
- Scan mirror actuator flight models have completed mechanical assembly

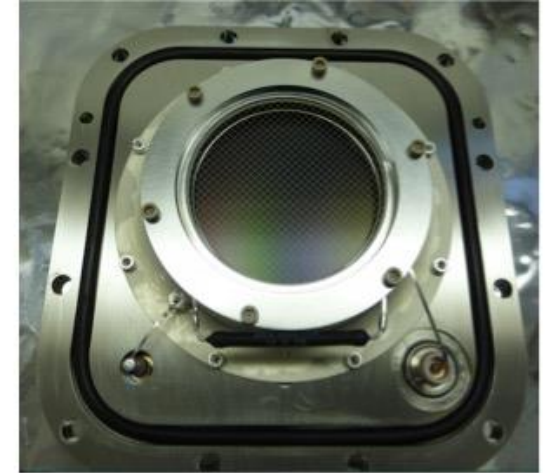
Upcoming Milestones/Events:

- CDR – 26-30 October 2015
- Pre-Environmental Review - March 2016
- Pre-Ship Review - October 2016
- Launch Readiness Date - April 2017

Issues/Concerns:

- Potential for schedule impacts from LASP production capacity and detector delivery delays. Continuing to monitor and prioritize GOLD detector assembly and test activities.
- IRD indicates a potential for high (200V/m) radiative emissions. Added one week of EMI testing to evaluate the implemented mitigations; considering additional EM hardware tests.

GOLD Detector Section





SPP

- Solar Probe Plus -



Recent Accomplishments

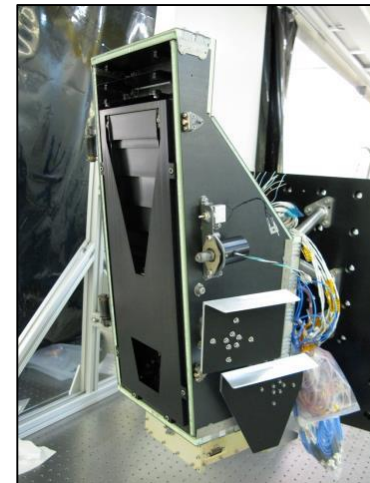
- TPS: Completed Fracture Toughness Testing at NASA Langley
- Solar Array: Completed qualification S/A wing bakeout/outgassing and acoustic test
- Software: Completed ground software Build 2
- GN&C: Successfully completed the CDR for reaction wheels at Rockwell Collins Deutschland
- FIELDS: Completed thermal balance testing of antennas
- WISPR: Successfully completed Opto-Mechanical Qualification Model vibration testing
- ISIS: Vibration test of EPI-Hi LO thin detector completed

Upcoming Milestones/Events

- Guidance & Control Reaction Wheel Test Readiness Review – November 2015
- Mission Operations Review (MOR) – November 2015
- Flight Spacecraft Primary Structure Static Load Test – December 2015
- SIR - May 2016
- LRD - July 2018

Issues/Concerns

- Couple loads analysis indicated significant loads on FIELDS whip antenna. Update: Fabrication and testing of the clamshell design is underway.
- Spacecraft Structure Fabrication Delay; Initial assessment is approximately five weeks.



Fully Assembled WISPR QM on Vertical Test Stand

Recent Accomplishments:

- NASA/ESA Bilateral Meeting at ESTEC 22-23 Sep, conveyed importance of schedule adherence.
- LV Technical Interface Meetings between SoloHI/HIS instrument teams and ESA/Airbus closed out all open issues with interface documents.
- HIS Detector Section Time-of-Flight (DS ToF) Phase 1B testing completed, demonstrating aliveness of sensor, ToF and Energy resolution of various species and linearity.
- SoloHI sub-system bakeout ongoing.

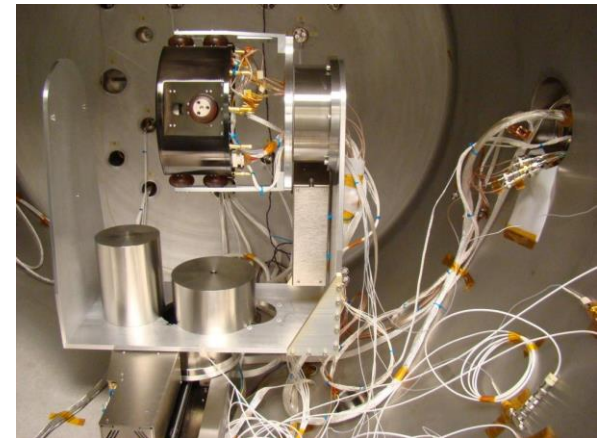
Upcoming Milestones/Events:

- | | |
|----------------------------------|--------------|
| • Mission CDR Decision Meeting | Dec 2015 |
| • Mission CDR Kick-Off/Close-Out | Jan/Feb 2016 |
| • SoloHI PER | Feb 2016 |
| • HIS PER | Mar 2016 |

Issues/Concerns:

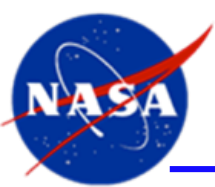
- Current ESA schedule reports no schedule margin for delivery of observatory. ESA taking action to recapture schedule margin. Schedule update and CDR progress check expected end of October/1st week of November.

HIS DS ToF in Test Chamber



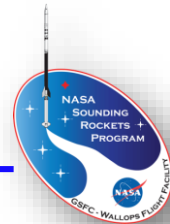


Sounding Rockets



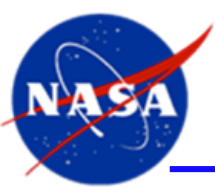
Sounding Rockets Launch Schedule

October 2015 – September 2016

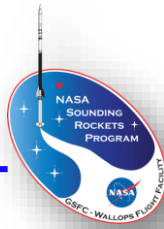


(16 Science, 3 Reimbursable)

#	Vehicle Type	Veh. No.	Experimenter	FY 2016												
				Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
WALLOPS ISLAND																
1	Black Brant IX	36.310 GT	HESH/NASA-WFF	▲												
2	Terrier Imp Malemute	46.011 GP	MILLINER/NASA-WFF		△											
3	Terrier Improved Orion	41.114 NP	DELEON/NASA-ARC							△						
4	Test Vehicle	12.078 GT	MILLINER/NASA-WFF								△					
5	Black Brant IX	36.317 GP	HESH/NASA-WFF													△
WSMR																
6	Black Brant IX	36.312 UG	MCCANDLISS/JHU					△								
7	Black Brant IX	36.293 UG	CHAKRABARTI/U. OF MASS/LOWELL		△											
8	Black Brant IX	36.307 DS	TUN BELTRAN/NRL			△										
9	Black Brant IX	36.305 UH	GALEAZZI/UNIV. OF MIAMI			△										
10	Black Brant IX	36.297 UG	FRANCE/UNIV. OF COLORADO						△							
11	Black Brant IX	36.309 US	HASSLER/SWRI							△						
12	Black Brant IX	36.245 UH	FIGUEROA/MIT							△						
13	Black Brant IX	36.314 NS	CIRTAIN/NASA-MSFC										△			
14	Black Brant IX	36.281 UE	BOCK/CAL TECH											△		
15	Black Brant IX	36.318 US	WOODS/UNIV COLORADO										△			
16	Black Brant IX	36.262 UG	KAISER/JHU												△	
NORWAY																
17	Black Brant XIA	52.002 UE	LESSARD/U. OF NEW HAMPSHIRE		△											
18	Oriole IV	49.003 UE	LABELLE/DARTMOUTH COLLEGE		△											
REIMBURSABLE MISSIONS																
19	Test Vehicle	12.080 DR	CHRISLEY/ZOMBIE												△	



Sounding Rockets Highlights



- **Hesh Mission – Successful launch from Wallops Flight Facility on 7 October**
 - Successfully demonstrated the new Black Brant MkIV rocket motor. Performance was nominal with no evidence of combustion instability. (NASA will continue to monitor the Black Brant motor performance for some time until the risk is fully retired.)
 - Delivered two technology demonstration experiments sponsored by STMD Game Changing Development

Langley Interns Watch Tech They Worked on Go to Space (and Come Back)



Eight NASA Langley interns worked on payloads that launched aboard a Black Brant IX sounding rocket from Wallops Flight Facility Oct. 7.
Credits: NASA/David C. Bowman

Black Brant Mk IV on Launch Rail



Representatives from NASA and Orbital ATK examine the Black Brant the day before launch.
Credits: NASA/David C. Bowman



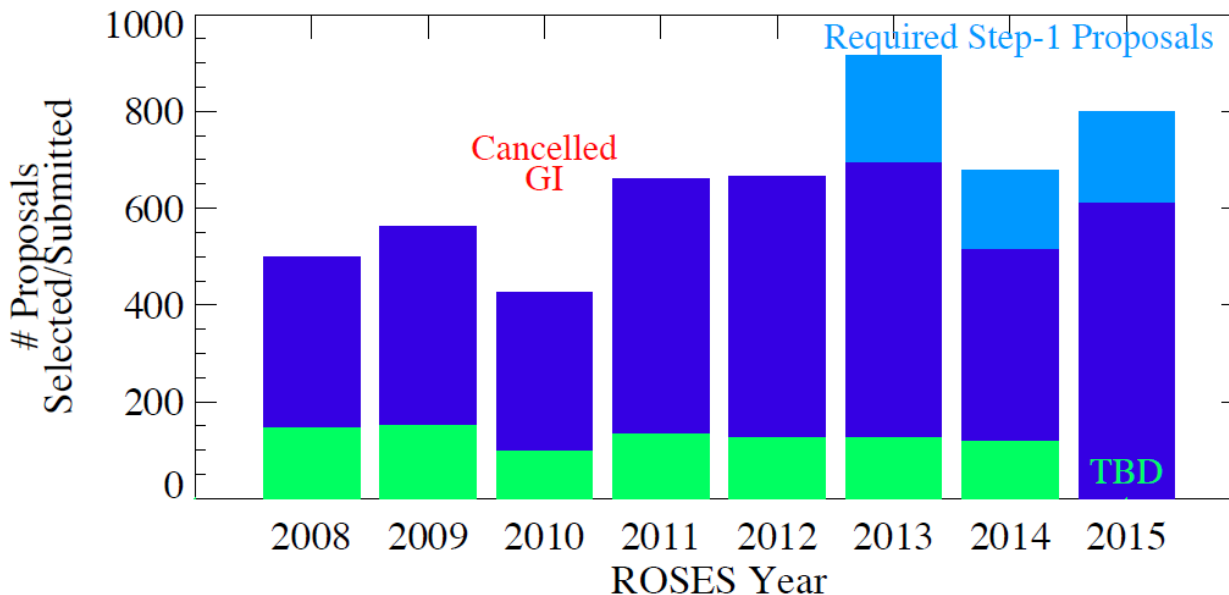
Research & Analysis



HPD 2015 ROSES Award Status



ELEMENT	STEP 1 PROPOSALS	STEP 2 PROPOSALS	AWARDS (ESTIMATED)	YEAR 1 (\$M) (ESTIMATED)
B.2 H-SR	343	251	(25 – 33)	4.5
B.3 H-TIDeS	135	106	(15)	5.5
B.4 H-GI	204	149	(20 – 25)	3.1
B.6 H-LWS	103	92	20	3.5
B.7 H-IDEE	15	14	(10 – 12)	0.5
TOTALS	799	612	(90 – 105)	17.1



**Expected ROSES15
Average Success
Rate (vs. Full
Proposals):
15 – 17%**

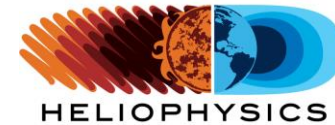
Reviews Ongoing



National Space Weather Strategy



National Space Weather Strategy



- The Office of Science Technology Policy (OSTP), Executive Office of the President, led the multi-agency effort to develop a National Space Weather Strategy (NSWS), which was officially released on 29 October.
- The NSWS articulates strategic goals for improving forecasting, impact evaluation, and enhancing National Preparedness (protection, mitigation, response and recovery) to a severe space weather event.
- A Space Weather Action Plan (SWAP) has been developed to establish cross-Agency actions, timelines and milestones for the implementation of the NSWS.
- The Action Plan will:
 - Enhance the transition of research to operations for space weather observations, modeling tools, advance warning capabilities and mitigation approaches
 - Incorporate severe space weather events in Federal emergency preparedness, planning, scenarios, training, and exercises
 - Establish Federal and non-Federal stakeholder collaborations to enhance observing systems and networks and data management activities



Division Strategy



Heliophysics Division Strategy



Primary Focus

Ensure a more balanced Heliophysics portfolio and enable a continuing robust and long-term Heliophysics System Observatory and research programs.

- ✓ **Assessing Division Resource Needs**
- ✓ **Re-Balancing Staff Work-Load**
- ✓ **Participating in OSTP-led Space Weather Operations, Research and Mitigation (SWORM) Task Force activities**
- ✓ **Develop Division Technology Investment Focus**
 - **Technology Investment Plan development initiated**
- ✓ **Enhance Inter-Agency and International Partnerships**
 - **In discussions with NOAA, Air Force, NSF on future collaborations**
 - **Met with Indian Space Research Organisation (ISRO) representatives in August; discussions underway to establish a NASA-ISRO Heliophysics Working Group**
 - **Bilateral discussions with ESA in September**
 - **In discussions with JAXA concerning Solar-C path forward**



Heliophysics Division Strategy



- ✓ **Engage the Heliophysics Community**
 - **Heliophysics Subcommittee meeting (29-30 September)**
 - **Visited Southwest Research Institute (7-8 October)**
 - **Presented at the Committee for Solar and Space Physics (14-15 October)**
 - **Presented and participated in the Space Weather Enterprise Forum (20-21 October)**
 - **Scheduled visits to the University of Michigan and Smithsonian Astrophysical Observatory (18-19 November)**
 - **American Geophysical Union (14-18 December)**

- **Develop and Implement Long-Term Strategy for a Balanced Portfolio**
 - **Plan for more frequent, lower-cost missions by expanding Explorers and Missions of Opportunity**
 - **Commence development of the highest priority Strategic Program (STP, LWS) science targets, consistent with the budget and with Research and Explorer priorities**
 - **Work towards enhancing research programs (DRIVE) as recommended by the Decadal Survey**