



# HELIOPHYSICS DIVISION



*Flight Program Status  
Heliophysics Subcommittee Meeting  
September 29, 2015  
Peg Luce, Deputy Director*

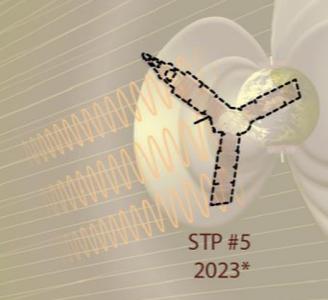
# Heliophysics Program 2015-2024

\* Notional

Solar Terrestrial Probes

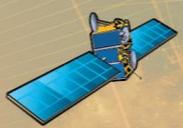


Magnetospheric Multiscale (MMS)  
March 2015



STP #5  
2023\*

Living With a Star



Space Environment Testbeds (SET)  
October 2016

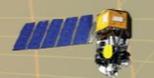


Solar Probe Plus  
July 2018

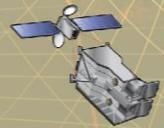


Solar Orbiter Collaboration (with ESA)  
October 2018

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 - September 2015  
UV/Optical Astrophysics - November 2015  
Geospace - November 2015  
Geospace - November 2015

Solar/Heliospheric - December 2015  
High Energy Astrophysics - December 2015  
UV/Optical Astrophysics - December 2015

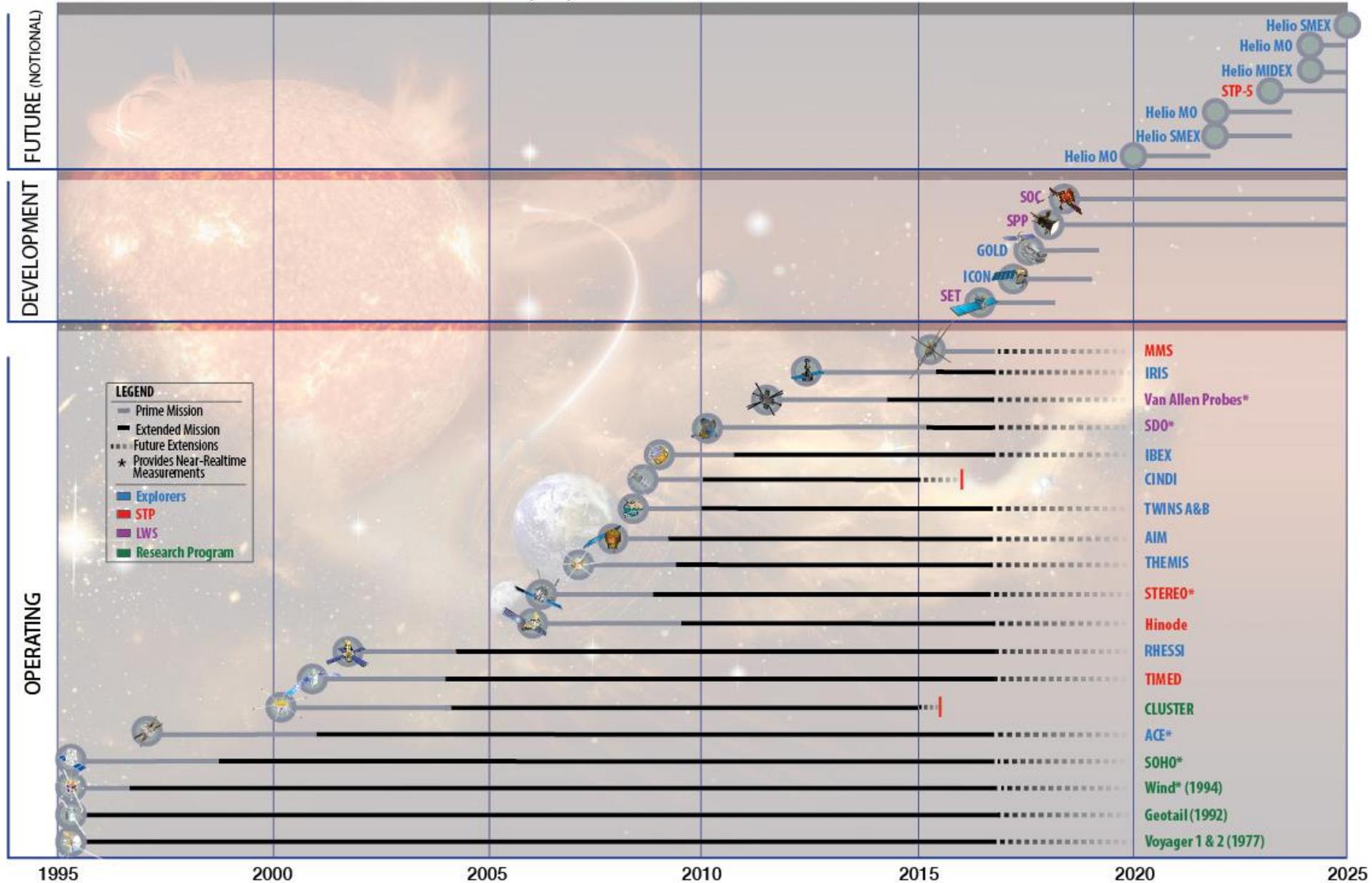
HASP - September 2015  
RAD-X - September 2015  
GRIPPS - December 2015

Heliophysics Missions  
Astrophysics Missions  
Planetary Missions

Ongoing

2015 2016 2017 2018 2019 2020 2021 2022 2023 2024

# Heliophysics Mission Timeline 1995-2025





# Magnetospheric Multiscale (MMS) Mission



**Description:** MMS is a Solar Terrestrial Probes mission with four identically instrumented spacecraft that use Earth's magnetosphere as a laboratory to study the microphysics of magnetic reconnection.

**Launched 3/12/2015, the MMS constellation's orbit, spin rates and attitudes are nominal, and initial science results are excellent.**

## Recent Accomplishments:

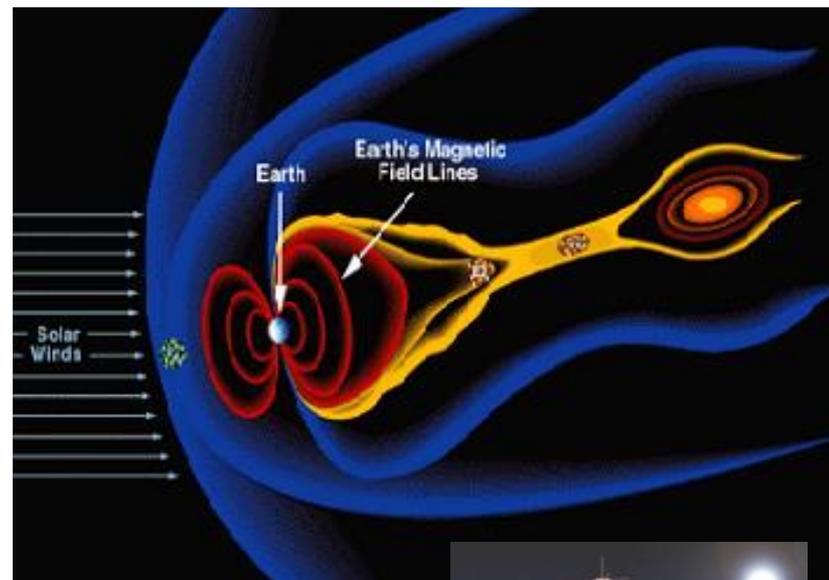
- Mission entered Phase E on 9/1/2015
- Performed formation resizing maneuvers to successfully decrease the probe separation from 160 km to 60 km on 9/16-17; current orbit size is 1.2 x 12 Earth Radii.

## Planning Items:

- Phase 1a Formation Resizing Maneuvers:
  - 60 km to 25 km – 9/30
  - 25km to 10 km – 10/14
  - 10km to TBD km – 12/16
- Phase 1x Begins: March 2016
- Phase 1b Begins: September 2016

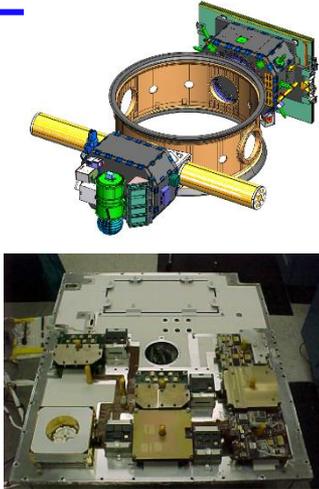
## Watch Items/Concerns:

- Anomaly Review Board is investigating an anomaly in which science data from Spacecraft #2 stopped flowing during downlink on 9/26.





# 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 degree 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; and 3) developing & validating engineering environment models, tools, & databases for spacecraft design & operations

## **Upcoming Milestones:**

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

## **Accomplishments:**

- All flight hardware has been delivered, including the separation system for the DSX secondary payload.
- Activities scheduled for FY16 include work with the separation system, mission readiness review (MRR), and 4 mission rehearsals.

## **Watch Items/Concerns:**

- None



# Ionospheric Connection Explorer (ICON)

**Description:** ICON will explore the boundary between Earth and space to understand the physical connection between our world and our space environment. ICON will 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 payload consists 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

## Upcoming Milestones:

- System Integration Review – June 2016
- Pre-Environmental Review – August 2016
- LRD – Oct 2017

## Recent Accomplishments:

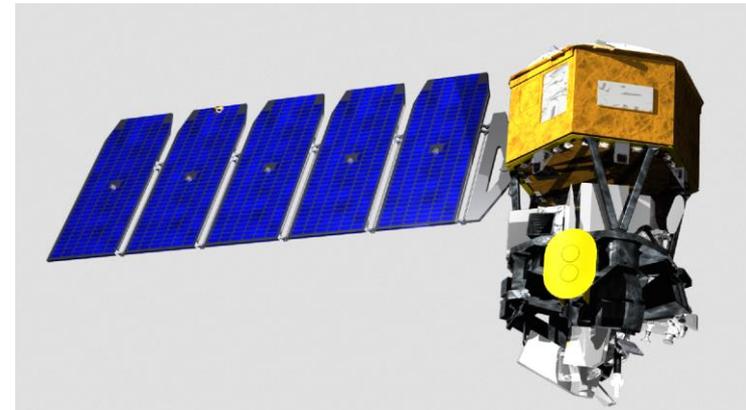
- Mission CDR completed April 9, 2015
- Spacecraft structure fabrication completed and structural load testing completed
- MIGHTI EM completed and vibration testing completed
- FUV instrument shipped to CSL (Belgium)
  - Turret EM vibration completed and flight turret assembled; structural resonance issue resolved.
  - Optics integrated to chassis, final alignment verified
- EUV: Instrument integrated, and in optical/functional testing
- Decision reached not to change launch site.

## Watch Items/Concerns:

- Instrument Control Panel now critical path due to delay of flight digital board layout & build



**Flight Structure**





# GOLD

# 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 a UV imaging spectrograph as a hosted payload on a commercial communications spacecraft in geostationary orbit.

### Upcoming Milestones:

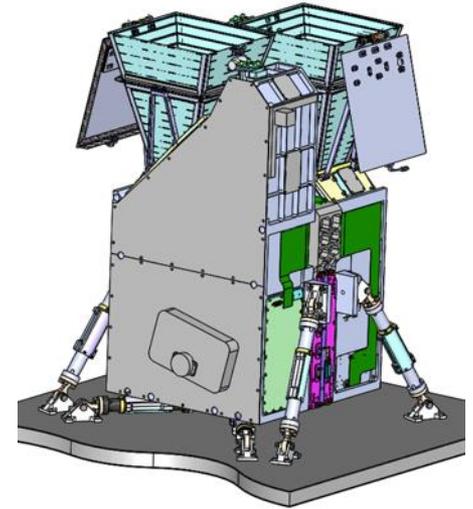
- Critical Design Review – 26-30 October 2015
- Pre-Environmental Review - March 2016
- Pre-Ship Review - October 2016
- Launch Readiness Date - April 2018

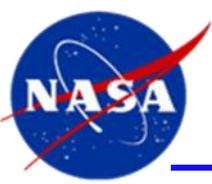
### Recent Accomplishments:

- Engineering Model struts have been assembled.
- Flight detectors processing continues.

### Watch Items/Concerns:

- Lightshade on critical path; mitigating coating issues using Germanium Black Kapton Tape.
- Interface Requirements Doc't indicates a potential for high (45V/m) radiative emissions. TIM determined that housing design was sufficient, but additional mitigations are also being considered.





# Solar Probe Plus (SPP)



## 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

- Mission Operations Review – Nov 2015
- System Integration Review – June 2016
- LRD – July 2018



## Recent Accomplishments

- TPS: Completed edge closeout testing at C-CAT (Carbon-Carbon Advanced Technologies, Inc.)
- Cooling System: Successfully completed thermal cycle acceptance testing of 24 of 48 radiator fins
- Solar Array: Completed initial impedance tests and began bakeout of qualification S/A wing
- G&C: Successfully completed the test readiness review for flight Sun sensor system
- FIELDS: Completed antenna testing with maximum Truss Structure Assembly spacer
- SWEAP: Completed Solar Probe Cup Moog Engineering Dev't Unit test

## Watch Items/Concerns

- Coupled loads analysis indicated significant loads on FIELDS whip antenna.
- DSN costs are increasing – initiated discussions between the project and SCAN.



# Solar Orbiter Collaboration (SOC)



**Description:** Will use a unique combination of measurements: *In situ* measurements will be used alongside remote sensing, close to the Sun ( $\sim 0.3$  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:

- Required Instrument Deliveries to ESA/Airbus: October 2016 (TBC)
- LRD October 2018

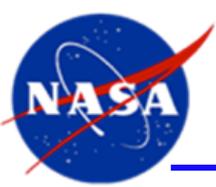
## Recent Accomplishments:

- KDP-C March 2013– For NASA-contributed instruments (HIS, SoloHI)
- Heavy Ion Sensor (HIS):
  - Integration and Test Phase 1 Underway
  - Detector Section-Time Of Flight (DS-TOF) Integrated with Flight Model boards
  - First-Light Test conducted showing triple coincidence
  - Electrical Model Delivered and successfully communicated with SWA DPU
- Solar Orbiter Heliospheric Imager (SoloHI):
  - Integration and Test Underway
  - Electrical Model Delivered and Integrated on ESA Solar Orbiter Electrical Test Bed (ETB)
  - First SO Instrument to Successfully Send Data Through the ETB

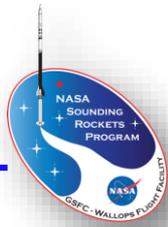


## Watch Items/Concerns:

- Mission schedule uncertainties; ESA/Airbus working to recover schedule reserve.



# Recent Sounding Rocket Launches



- **Kankelborg Mission – Successful launch from White Sands Missile Range, NM on 27 August**
  - An investigation of the transition region of the Sun (the layer of material where the photosphere, the layer of the Sun we see, becomes the corona) to better understand why the Sun’s atmosphere is approximately 1,000 times hotter than its surface
- **Winebarger Mission – Successful launch from White Sands Missile Range, NM on 3 September**
  - An investigation to achieve the first measurement of the Sun’s magnetic field in the upper chromosphere and transition region of the Sun through the detection and measurement of Hanle effect polarization of the Lyman alpha line
  - Black Brant Motor performed nominally, showing no combustion instability
- **Bernhart Mission – Successful launch from Andøya, Norway on 16 September**
  - A Naval Research Laboratory experiment to examine the effect of artificially created charged-particulate layers on the scatter of UHF, L-Band, and S-Band radars.



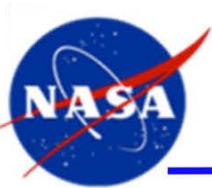
Kankelborg



Winebarger



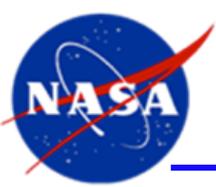
Andøya Rocket Range, Norway



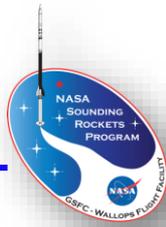
# Schedule of Sounding Rocket Launches



	PI Name	PROJECT	SITE	Start Date	2015												2016			
					May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr				
1	MCENTAFFER	OGRESS	WS	5/4/15	◆															
2	WOODS	EVE	WS	5/21/15	▼ Incorrect Gyro Install															
3	KOEHLER	ROCKON	WI	6/25/15		◆														
4	MILLINER		WI	7/7/15			◆													
5	KOEHLER	ROCKSAT-X	WI	8/12/15				◆												
6	WINEBARGER	CLASP	WS	9/3/15					◆											
7	<b>BERNHARDT</b>	CARE II	NOR	9/7/15					◆											
8	HESH	<b>BLACK BRANT</b>	WI	10/6/15							▼									
9	MILLINER	MUSIC	WI	10/14/15							▼									
11	<b>GILBERT</b>	SPRINT	WS	10/29/15								▼								
13	LESSARD	RENU 2	NOR	11/20/15									▼							
14	LABELLE	CAPER	NOR	11/20/15										▼						
15	GALEAZZI	DXL-2	WS	12/4/15											▼					
16	TUN BELTRAN	HERSCHEL	WS	12/14/15												▼				
10	MCCANDLISS	FORTIS	WS	1/7/16													▼			
12	CHAKRABARTI	PICTURE	WS	1/7/16														▼		
17	KAISER	ACCESS #1	WS	1/19/16															▼	
18	FRANCE	CHESS-2	WS	2/22/16															▼	
19	HASSLER	RAISE	WS	3/1/16															▼	
20	GILBERT	SPRINT	WS	3/1/16															▼	
21	DELEON		WI	3/4/16															▼	
22	DELEON		WI	3/4/16															▼	
23	FIGUEROA	MICRO-X	WS	3/23/16															▼	
24	MILLINER		WI	4/1/16															▼	
25	CHRISLEY	ZOMBIE	WS	4/6/16															▼	



# Sounding Rockets and Range



## Upcoming Milestones:

- **Sounding Rockets** –The first test flight for the Black Brant Mk IV is scheduled for NET October 6 from Wallops Island.

## Recent Accomplishments:

- **50K Launcher Relocation and Refurbishment**
  - Structural concrete completed, continuing construction of concrete paved areas
  - Project remains on schedule with a plan for the launcher boom to be set in early October



*50K Launcher Structural Concrete*

## Watch Items/Concerns:

- **Peregrine Motor Development:** Evaluating funding and options.



# Operating Mission Suite



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	Green with diagonal lines	STEREO-B ping moved to 3/2016			
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	
Cluster	7/16/2000	Extended	9/30/2015 (+)	Green	Green with vertical lines	Green with vertical lines	Black	NASA supports ends 10/1/2015
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	
IRIS	6/27/2013	Extended	9/30/2018	Green	Green	Green	Green	
MMS	3/12/2015	Prime	9/1/2017	Green	Green	Green	Green	Successful PLAR 8/2015 - in Phase E.

(\*) 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