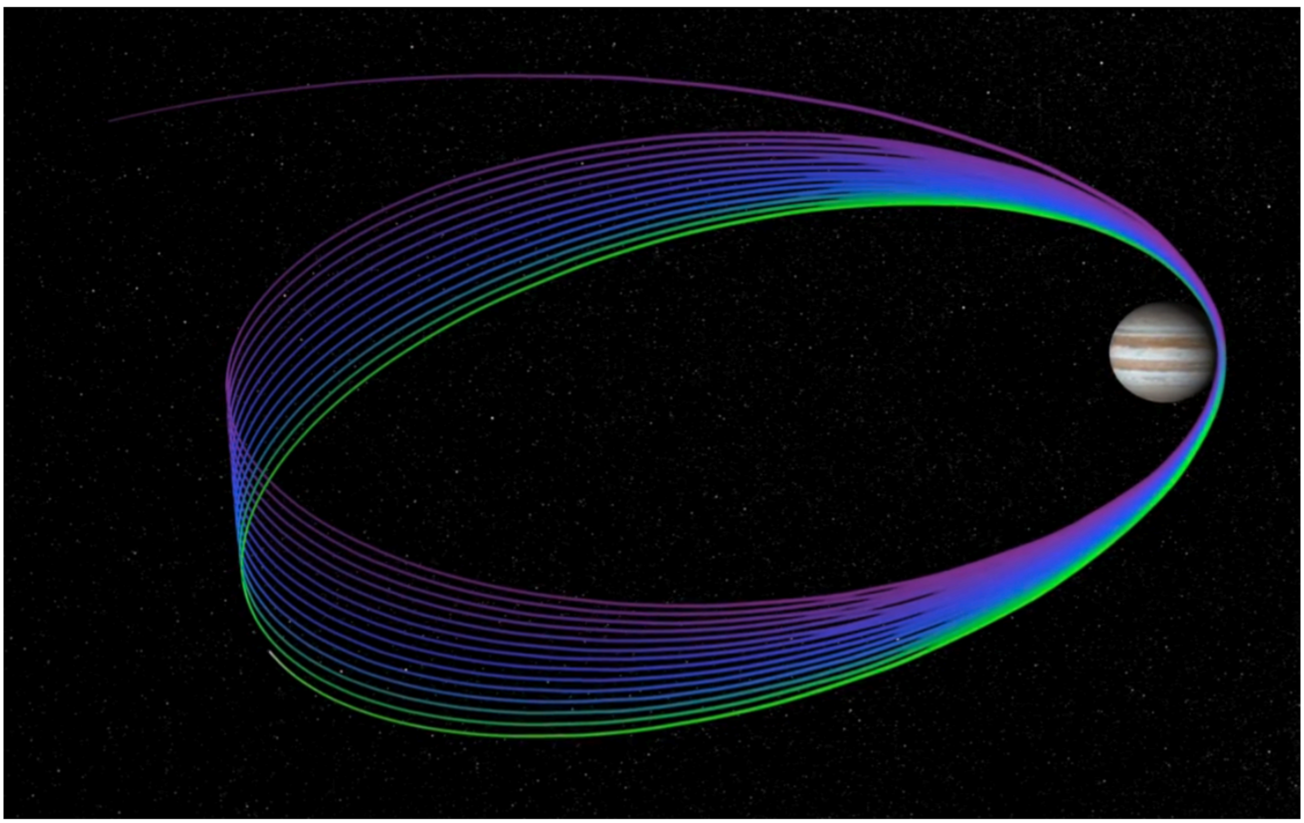
Juno
Mission Description

2012-03-12 JUNO: Kurth Revision 1
2015-08-15 JUNO: Kurth and Stephens Revision 2



Juno Mission Description

The majority of the text in this file was extracted from the Juno Mission Plan Document, S. Stephens, 29 March 2011. [JPL D-35556]

Overview

Juno launched on 5 August 2011. The spacecraft uses a deltaV-EGA trajectory consisting of a two-part deep space maneuver on 30 August and 14 September 2012 followed by an Earth gravity assist on 9 October 2013 at an altitude of 559 km.

Jupiter arrival is on 5 July 2016 using two 53.5-day capture orbits prior to commencing operations for a 1.3-(Earth) year-long prime mission comprising 32 high inclination, high eccentricity orbits of Jupiter. The orbit is polar (90 degree inclination) with a periapsis altitude of 4200-8000 km and a semi-major axis of 23.4 RJ (Jovian radius) giving an orbital period of 13.965 days. The primary science is acquired for approximately 6 hours centered on each periapsis although fields and particles data are acquired at low rates for the remaining apoapsis portion of each orbit.

Currently, periapses 4, 6, 7, 8, 9 and 14 are dedicated to microwave radiometry of Jupiter's deep atmosphere with the remaining orbits dedicated to gravity measurements to determine the structure of Jupiter's interior. All orbits will include fields and particles measurements of the planet's auroral regions. Juno is spin stabilized with a rotation rate of 2 rotations per minute (RPM). For the radiometry orbits the spin axis is precisely perpendicular to the orbit plane so that the radiometer fields of view pass through the nadir. For gravity passes, the spin axis is aligned to the Earth direction, allowing for Doppler measurements through the periapsis portion of the orbit. The orbit plane is initially very close to perpendicular to the Sun-Jupiter line and evolves over the 1.3-year mission. Generally, data acquired during the periapsis passes are recorded and played back over the subsequent apoapsis portion of the orbit, although some data can be downlinked during the gravity passes.

Juno's instrument complement includes Gravity Science using the X and Ka bands to determine the structure of Jupiter's interior; magnetometer investigation (MAG) to study the magnetic dynamo and interior of Jupiter as well as to explore the polar magnetosphere; and a microwave radiometer (MWR) experiment covering 6 wavelengths between 1.3 and 50 cm to perform deep atmospheric sounding and composition measurements. The instrument complement also includes a suite of fields and particle instruments to study the polar magnetosphere and Jupiter's aurora. This suite includes an energetic particle detector (JEDI), a Jovian auroral (plasma) distributions experiment (JADE), a radio and plasma wave instrument (Waves), an ultraviolet spectrometer (UVS), and a Jupiter infrared auroral mapping instrument (JIRAM). The JunoCam is a camera included for education and public outreach. While this is not a science instrument, we plan to capture the data and archive them in the PDS along with the other mission data. The MAG investigation consists of redundant flux gate magnetometers (FGM) and co-located advanced stellar compasses (ASC). The ASCs are provided by the Danish Technical University under an effort led by John Jorgenson.

Scott Bolton is the Juno Principal Investigator. The Science Team members responsible for the delivery and operation of the instruments are listed below:

Instrument	Acronym	Lead Co-I
Gravity Science	GRAV	Folkner
Magnetometer	MAG	Connerney
Microwave Radiometer	MWR	Janssen
Jupiter Energetic Particle Detector Instrument	JEDI	Mauk
Jovian Auroral Distributions Experiment	JADE	McComas
Radio and plasma wave instrument	Waves	Kurth
Ultraviolet Imaging Spectrograph	UVS	Gladstone
Jovian Infrared Auroral Mapper	JIRAM	Adriani
Juno color, visible-light camera	JUNOCAM	Hansen

Mission Phases

LAUNCH

The Launch phase starts at L-40 min (Launch-40 min), and covers the interval from launch, through initial ground station acquisition, until the establishment of a pre-defined, stable, and slowly changing Sun-pointed attitude when cruise attitude control algorithms and ephemerides can be used. The end of the Launch phase is determined by post-launch health and safety assessments. The boundary is at L+3 days, after initial acquisition and after confirmation that the Flight System is safe and in a power-positive, thermally stable, and commandable attitude.

Target Name - N/A
Mission Phase Start Time - 2011-08-05 (2011-217)
Mission Phase Stop Time - 2011-08-08 (2011-220)

INNER CRUISE 1

The Inner Cruise 1 phase lasts from post-Launch establishment of a pre-defined and stable Sun-pointed attitude when cruise attitude control algorithms and ephemerides can be used, until after initial spacecraft and instrument checkouts have been performed and the spacecraft has gotten far enough from the Sun to allow Earth-pointing instead of Sun-pointing. TCM 1 (the first planned trajectory correction maneuver) was deemed not necessary, hence, was not executed. The phase spans the interval from L+3 to L+66 days.

Target Name - SOLAR_SYSTEM
Mission Phase Start Time - 2011-08-08 (2011-220)
Mission Phase Stop Time - 2011-10-10 (2011-283)

INNER CRUISE 2

The Inner Cruise 2 phase spans the period from L+66 days until L+663 days. The Deep Space Maneuvers (DSMs) occur during this phase, near aphelion of Juno's first orbit about the Sun, on the way to Earth Flyby and then Jupiter. There is increased DSN (Deep Space Network) coverage associated with the DSMs and a cleanup TCM. DSMs 1 and 2 occur on 2012-08-30 and 2010-09-14.

Target Name - SOLAR_SYSTEM
Mission Phase Start Time - 2011-10-10 (2011-283)
Mission Phase Stop Time - 2013-05-29 (2013-149)

INNER CRUISE 3

The Inner Cruise 3 phase spans the interval from L+663 days to L+823 days. The duration of this cruise phase is 160 days. Featured in this phase is Earth Flyby (EFB), which gives Juno a gravity assist (providing ~7.3 km/s of delta V) on its way to Jupiter. It occurs as the spacecraft is completing one elliptical orbit around the Sun and includes perihelion. Three TCMs were planned before EFB (the last of which was deemed not necessary) and one after EFB. There is increased DSN coverage associated with the 4 maneuvers and EFB. The Inner Cruise 3 phase is focused on performing the required maneuvers, as well as an integrated operations exercise around Earth Flyby, subject to Flight System constraints. Closest approach to Earth occurs on 2013-10-09 at 19:21 UTC.

Target Name - EARTH, SOLAR_SYSTEM
Mission Phase Start Time - 2013-05-29 (2013-149)
Mission Phase Stop Time - 2013-11-05 (2013-309)

Earth Closest Approach - 2013-10-09T19:21 (2013-282)

OUTER CRUISE

The Outer Cruise phase lasts from L+823 days until the start of Jupiter Approach at Jupiter Orbit Insertion (JOI)-6 months (JOI-182 days or L+1614 days). The duration of this cruise phase is 791 days, which is over 2 years.

Target Name - SOLAR_SYSTEM
Mission Phase Start Time - 2013-11-05 (2013-309)
Mission Phase Stop Time - 2016-01-05 (2016-005)

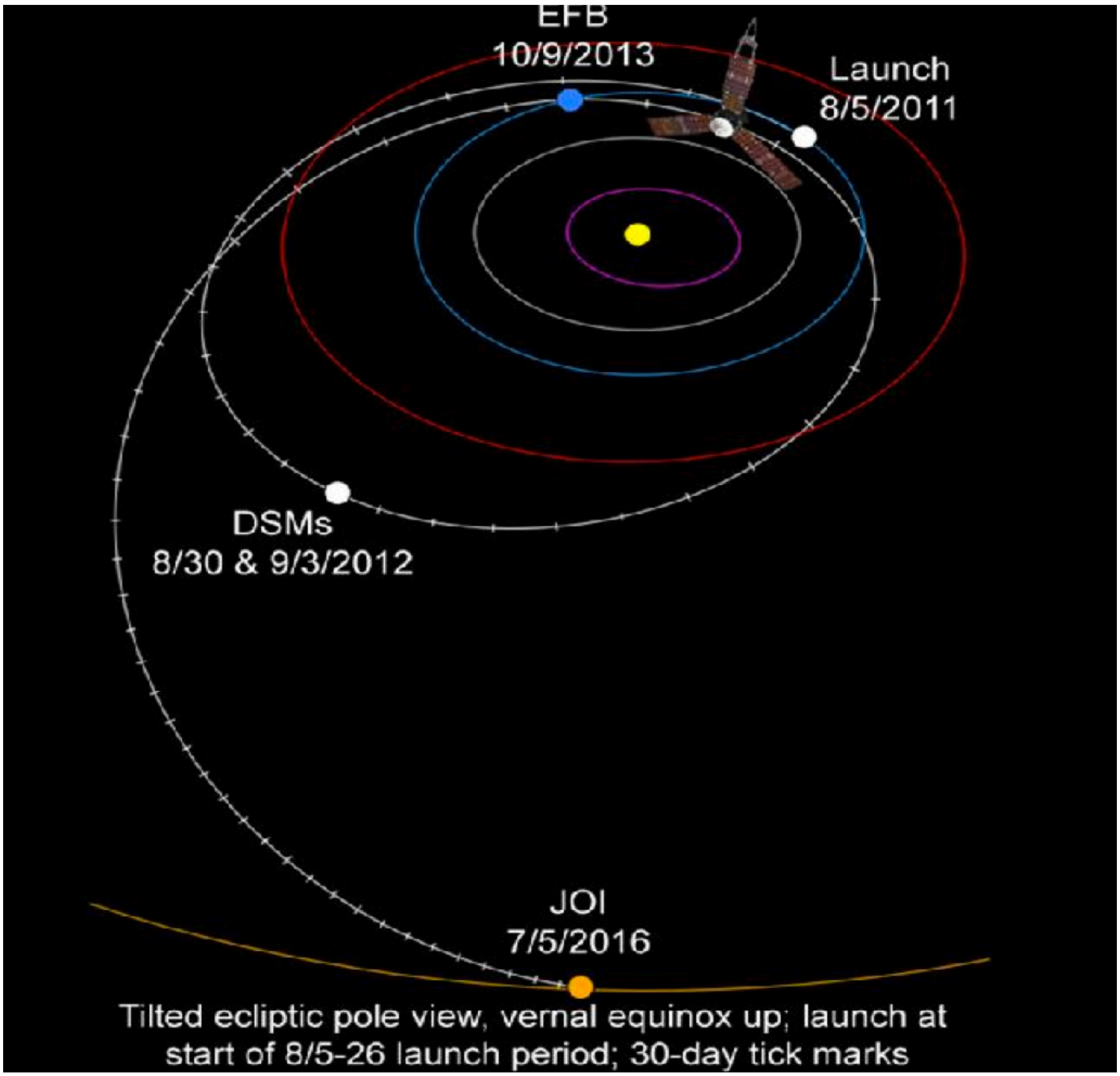


Figure 1. Juno's Cruise Trajectory

JUPITER APPROACH

The Jupiter Approach phase lasts the final 6 months of cruise before Jupiter Orbit Insertion and is an opportunity for final Flight System and instrument checkouts as well as science observations to start exercising the ground system and Flight System, although orbit insertion preparations limit instrument activities close to JOI. There are more frequent maneuvers approaching JOI, starting with a TCM at JOI-5 months, and correspondingly increasing DSN coverage. The 178-day Jupiter Approach phase is preceded by a 26-month Outer Cruise phase. Jupiter Approach starts 3 months after the project is fully staffed up in preparation for JOI and the 1.3 years of science orbits. The phase ends at JOI-4 days, which is the start of the JOI critical sequence.

Target Name: - JUPITER, SOLAR_SYSTEM
Mission Phase Start Time - 2016-01-05 (2016-005)
Mission Phase Stop Time - 2016-07-01 (2016-183)

JUPITER ORBIT INSERTION

The JOI phase encompasses the JOI critical sequence. It begins 4 days before the start of the orbit insertion maneuver and ends 1 hour after the start. JOI, the second critical event of the mission, occurs at closest approach to Jupiter, and slows the spacecraft enough to let it be captured by Jupiter into a 53.5-day orbit and set up the geometry for the 14-day science orbits. A cleanup burn at JOI+8.6d during the Capture Orbit phase is required to clean up JOI maneuver execution errors. DSN coverage is continuous during the JOI phase.

Target Name - N/A
Mission Phase Start Time - 2016-07-01 (2016-183)
Mission Phase Stop Time - 2016-07-05 (2016-187)
Perijove 0 - 2016-07-05T02:47:38 (2016-187)

CAPTURE ORBIT

The Capture Orbits phase starts at JOI+1h, after the end of the JOI critical sequence, and ends at PRM-5.25d, when instruments are off in preparation for the PRM maneuver. Between the two 53.5d capture orbits is PJ1 (Perijove 1), at which no maneuver is planned so it can be used as the first opportunity for science close to Jupiter and an opportunity to test the performance of the instruments in the Jupiter environment. A JOI cleanup maneuver at JOI+8.6d is required to clean up JOI maneuver execution errors, while additional maneuvers near the first apojove following JOI and at PJ1+14d ensure the timing of PJ1 and the large PRM burn at perijove of the following orbit. Solar conjunction occurs after apojove of the second capture orbit. DSN coverage remains continuous until the JOI+8.6d maneuver, then remains at elevated levels throughout the two capture orbits, and is continuous again around PJ1 and before PRM. Instruments are on for most of the Capture Orbits, and there are routine checkouts and science observations.

Target Name - JUPITER, SOLAR_SYSTEM
Mission Phase Start Time - 2016-07-05 (2016-187)
Mission Phase Stop Time - 2016-10-14 (2016-288)
Perijove 1 - 2016-08-27T12:51:20 (2016-240)

PERIOD REDUCTION MANEUVER

The Period Reduction Maneuver phase starts at PRM-5.25d, and ends at PRM+50h, coinciding with the instrument keepout zone for the maneuver (no science observations are planned during this phase). The burn at PJ2 (Perijove 2) is designed to accomplish a decrease in the period and size of the orbit, thus the name Period Reduction Maneuver (PRM). PRM requires a cleanup maneuver in the following orbit to ensure proper timing for longitude coverage during the Science Orbits phase. DSN coverage is continuous from PRM-14d until PRM+5d.

Target Name - N/A
Mission Phase Start Time - 2016-10-14 (2016-288)
Mission Phase Stop Time - 2016-10-21 (2016-295)
Perijove 2 - 2016-10-19T18:11:07 (2016-293)

ORBITS 2-3

The Orbits 2-3 phase starts at PRM+50h, after the end of the instrument keepout zone for the Period Reduction Maneuver, and near the beginning of the first 14-day orbit. It ends at PJ4-1d, which is the start of the first activity period (MWR AP4) in the Science Orbits. As such, the Orbits 2-3 phase includes most of the last half of Orbit 2 (PJ2 to AJ2) and all of Orbit 3 (AJ2 to AJ3). DSN coverage is continuous from the start of the phase until PRM+5d, and then follows a pattern similar to that used for the Science Orbits template. Instrument checkouts after PRM and science observations during the rest of Orbit 2 and in Orbit 3 are planned.

Target Name - JUPITER
Mission Phase Start Time - 2016-10-21 (2016-295)
Mission Phase Stop Time - 2016-11-15 (2016-320)
Perijove 3 - 2016-11-02T17:52:29 (2016-307)

SCIENCE ORBITS

The Science Orbits phase includes Orbit 4 through Orbit 36. Orbit N is defined from apojove (AJ) N-1 through apojove N, and includes perijove (PJ) N. Orbit numbering starts before the Science Orbits phase. JOI occurs at PJ0, so Orbit 0 lasts from PJ0 through AJ0 (including a JOI cleanup maneuver at JOI+8.6d). Orbit 1 includes PJ1, and runs from AJ0 through AJ1. Orbit 2 includes PJ2 (and PRM at PJ2), and runs from AJ1 through AJ2. Orbit 0, Orbit 1, and the first half of Orbit 2 together contain the two 53.5-day capture orbits. Orbit

3 includes PJ3 (and the PRM cleanup maneuver at PJ3+6h), and runs from AJ2 through AJ3. Early orbital science is baselined in Orbits 0, 1, 2, and 3, except for JOI and PRM keepout zones. Orbit 4 is the first science orbit. It includes PJ4 (and the first OTM at PJ4+7.5h), and runs from AJ3 through AJ4. The last science orbit is Orbit 36. It is bookkept as an extra science orbit, since the mission uses Orbits 4 through 35 to obtain 32 perijoves with MAG and other data that meet Level-1 baseline science requirements. Small (up to 8 m/s) orbit trim maneuvers (OTMs) are planned after each set of perijove science observations, at PJ+4h, PJ+6h, or PJ+7.5h in Orbits 4 through 35, to target the perijove longitude required for science observations in the next orbit. There is no need for an OTM after PJ36. A deorbit maneuver (deterministic deltaV = 77 m/s) is planned near AJ36.

Table 1. Trajectory Event Times (150326 reference trajectory)

AP	Epoch	Date/Time	
		DOY	Calendar
	L [1]	217	F 08/05/11 16:25
	DSM 1	243	Th 08/30/12 22:30
	DSM 2	258	F 09/14/12 22:30
	EFB	282	W 10/09/13 19:21
	PJ0 [2]	187	Tu 07/05/16 02:48
	AJ0	213	Su 07/31/16 19:42
	PJ1	240	Sa 08/27/16 12:51
	AJ1	267	F 09/23/16 03:44
2	AP 2	292	Tu 10/18/16 18:00
PRM	PJ2 [3]	293	W 10/19/16 18:11
	AJ2	300	W 10/26/16 18:04
3	AP 3	306	Tu 11/01/16 17:00
PRM	PJ3	307	W 11/02/16 17:52
Cleanup	AJ3	314	W 11/09/16 17:25
4	AP 4	320	Tu 11/15/16 16:00
MWR	PJ4	321	W 11/16/16 16:55
	AJ4	328	W 11/23/16 16:23
5	AP5	334	Tu 11/29/16 15:00
GRAV	PJ5	335	W 11/30/16 15:52
	AJ5	342	W 12/07/16 15:20
6	AP 6	348	Tu 12/13/16 14:00
MWR	PJ6	349	W 12/14/16 14:50
	AJ6	356	W 12/21/16 14:17
7	AP 7	362	Tu 12/27/16 13:00
MWR	PJ7	363	W 12/28/16 13:48
	AJ7	004	W 01/04/17 13:52
8	AP 8	010	Tu 01/10/17 13:00
MWR	PJ8	011	W 01/11/17 14:00
Tilt	AJ8	018	W 01/18/17 13:26
9	AP 9	024	Tu 01/24/17 12:00
MWR	PJ9	025	W 01/25/17 12:57
	AJ9	032	W 02/01/17 12:24
10	AP 10	038	Tu 02/07/17 11:00
GRAV	PJ10	039	W 02/08/17 11:55
	AJ10	046	W 02/15/17 11:22
11	AP 11	052	Tu 02/21/17 10:00
GRAV	PJ11	053	W 02/22/17 10:52
	AJ11	060	W 03/01/17 10:02

AP	Epoch	Date/Time	
		DOY	Calendar
12	AP 12	066	Tu 03/07/17 09:00
GRAV	PJ12	067	W 03/08/17 09:13
	AJ12	074	W 03/15/17 08:43
13	AP 13	080	Tu 03/21/17 08:00
GRAV	PJ13	081	W 03/22/17 08:10
	AJ13	088	W 03/29/17 07:40
14	AP 14	094	Tu 04/04/17 07:00
MWR	PJ14	095	W 04/05/17 07:08
Tilt	AJ14	102	W 04/12/17 06:37
15	AP 15	108	Tu 04/18/17 06:00
GRAV	PJ15	109	W 04/19/17 06:05
	AJ15	116	W 04/26/17 06:12
16	AP 16	122	Tu 05/02/17 06:00
GRAV	PJ16	123	W 05/03/17 06:17
	AJ16	130	W 05/10/17 05:46
17	AP 17	136	Tu 05/16/17 05:00
GRAV	PJ17	137	W 05/17/17 05:15
	AJ17	144	W 05/24/17 04:44
18	AP 18	150	Tu 05/30/17 04:00
GRAV	PJ18	151	W 05/31/17 04:12
	AJ18	158	W 06/07/17 03:43
19	AP 19	164	Tu 06/13/17 03:00
GRAV	PJ19	165	W 06/14/17 03:10
	AJ19	172	W 06/21/17 03:28
20	AP 20	178	Tu 06/27/17 03:00
GRAV	PJ20	179	W 06/28/17 03:41
	AJ20	186	W 07/05/17 03:12
21	AP 21	192	Tu 07/11/17 02:00
GRAV	PJ21	193	W 07/12/17 02:38
	AJ21	200	W 07/19/17 02:09
22	AP 22	206	Tu 07/25/17 01:00
GRAV	PJ22	207	W 07/26/17 01:36
	AJ22	214	W 08/02/17 01:05
23	AP 23	220	Tu 08/08/17 00:00
GRAV	PJ23	221	W 08/09/17 00:33
	AJ23	228	W 08/16/17 00:20
24	AP 24	234	Tu 08/22/17 00:00
GRAV	PJ24	235	W 08/23/17 00:08
	AJ24	241	Tu 08/29/17 23:36

AP	Epoch	Date/Time	
		DOY	Calendar
25	AP 25	247	M 09/04/17 23:00
GRAV	PJ25	248	Tu 09/05/17 23:06
	AJ25	255	Tu 09/12/17 22:33
26	AP 26	261	M 09/18/17 22:00
GRAV	PJ26	262	Tu 09/19/17 22:03
	AJ26	269	Tu 09/26/17 21:30
27	AP 27	275	M 10/02/17 21:00
GRAV	PJ27	276	Tu 10/03/17 21:01
	AJ27	283	Tu 10/10/17 20:47
28	AP 28	289	M 10/16/17 20:00
GRAV	PJ28	290	Tu 10/17/17 20:36
	AJ28	297	Tu 10/24/17 20:03
29	AP 29	303	M 10/30/17 19:00
GRAV	PJ29	304	Tu 10/31/17 19:33
	AJ29	311	Tu 11/07/17 19:02
30	AP 30	317	M 11/13/17 18:00
GRAV	PJ30	318	Tu 11/14/17 18:31
	AJ30	325	Tu 11/21/17 18:00
31	AP 31	331	M 11/27/17 17:00
GRAV	PJ31	332	Tu 11/28/17 17:28
	AJ31	339	Tu 12/05/17 17:17
32	AP 32	345	M 12/11/17 17:00
GRAV	PJ32	346	Tu 12/12/17 17:03
	AJ32	353	Tu 12/19/17 16:32
33	AP 33	359	M 12/25/17 16:00
GRAV	PJ33	360	Tu 12/26/17 16:00
	AJ33	367	Tu 01/02/18 15:29
34	AP 34	373	M 01/08/18 14:00
GRAV	PJ34	374	Tu 01/09/18 14:58
	AJ34	381	Tu 01/16/18 14:26
35	AP 35	387	M 01/22/18 13:00
GRAV	PJ35	388	Tu 01/23/18 13:55
	AJ35	395	Tu 01/30/18 13:23
36	AP 36	401	M 02/05/18 12:00
Extra	PJ36	402	Tu 02/06/18 12:53
	AJ36	409	Tu 02/13/18 12:37
37	AP End	415	M 02/19/18 11:00
Impact	PJ37	416	Tu 02/20/18 11:40

[1] L = Launch; TIP was 08/05/11 17:25.
[2] JOI starts 07/05/2016 02:30 (duration = 35:09 min = 2109 s).
[3] PRM starts 10/19/2016 18:00 (duration = 22:03 min = 1323 s).

We distinguish activity periods from orbits. Orbits are used to refer to the mission design and navigation strategy (e.g., Nav data cutoffs, which occur near AJ orbit boundaries, and trajectory events), while activity periods are used to describe science and mission operations (e.g., sequences and data flow). An activity period (AP) runs from one PJ-1d to the next PJ-1d. Each AP is defined by the number of the PJ science pass it contains, and the type (MWR or GRAV). AP2 and AP3 are the first 14-day activity periods (differing slightly from science orbits activity periods), and run from PJ2-1d through PJ3-1d and PJ3-1d through PJ4-1d. AP3 is followed by the first activity period during the Science Orbits, AP4 (an MWR type), from PJ4-1d through PJ5-1d. The Science Orbits phase begins at the start of AP4, and continues through AP36, which ends early, at AJ36-1h, before the deorbit burn in the Deorbit phase.

Radiation accumulation increases substantially as the orbital line of apsides rotates and perijove latitude increases from 3 degrees at JOI to 36 degrees at PJ36. There are currently no plans for an extended mission.

Target Name - JUPITER
Mission Phase Start Time - 2016-11-15 (2016-320)
Mission Phase Stop Time - 2018-02-13 (2018-044)
Perijove 4 - 2016-11-16T16:54:46 (2016-321)
Perijove 5 - 2016-11-30T15:52:21 (2016-335)
Perijove 6 - 2016-12-14T14:49:58 (2016-349)
Perijove 7 - 2016-12-28T13:47:35 (2016-363)
Perijove 8 - 2017-01-11T13:59:37 (2017-011)
Perijove 9 - 2017-01-25T12:57:12 (2017-025)
Perijove 10 - 2017-02-08T11:54:47 (2017-039)
Perijove 11 - 2017-02-22T10:52:21 (2017-053)
Perijove 12 - 2017-03-08T09:12:44 (2017-067)
Perijove 13 - 2017-03-22T08:10:19 (2017-081)
Perijove 14 - 2017-04-05T07:07:53 (2017-095)
Perijove 15 - 2017-04-19T06:05:27 (2017-109)
Perijove 16 - 2017-05-03T06:17:26 (2017-123)
Perijove 17 - 2017-05-17T05:14:57 (2017-137)
Perijove 18 - 2017-05-31T04:12:29 (2017-151)
Perijove 19 - 2017-06-14T03:10:03 (2017-165)
Perijove 20 - 2017-06-28T03:40:40 (2017-179)
Perijove 21 - 2017-07-12T02:38:12 (2017-193)
Perijove 22 - 2017-07-26T01:35:46 (2017-207)
Perijove 23 - 2017-08-09T00:33:19 (2017-221)
Perijove 24 - 2017-08-23T00:08:07 (2017-235)
Perijove 25 - 2017-09-05T23:05:44 (2017-248)
Perijove 26 - 2017-09-19T22:03:21 (2017-262)
Perijove 27 - 2017-10-03T21:00:55 (2017-276)
Perijove 28 - 2017-10-17T20:35:43 (2017-290)
Perijove 29 - 2017-10-31T19:33:14 (2017-304)
Perijove 30 - 2017-11-14T18:30:45 (2017-318)
Perijove 31 - 2017-11-28T17:28:16 (2017-332)
Perijove 32 - 2017-12-12T17:02:53 (2017-346)
Perijove 33 - 2017-12-26T16:00:20 (2017-360)
Perijove 34 - 2018-01-09T14:57:50 (2018-009)

Perijove 35 - 2018-01-23T13: 55:18 (2018-023)
Perijove 36 - 2018-02-06T12:52:47 (2018-037)

DEORBIT

The Deorbit phase occurs during the final perijove-to-perijove orbit of the mission. The 7-day phase starts several days after the Orbit 36 perijove science pass (part of the extra orbit) at AJ36-1h, before the start of the apojove deorbit maneuver (by which time we hope to have all or most of the PJ36 data on the ground). It continues through AJ36, and ends with Impact into Jupiter at PJ37. In order to meet planetary protection requirements and ensure that we do not impact Europa (as well as Ganymede and Callisto), the spacecraft performs a deorbit maneuver near apojove that reduces our orbital velocity and sends us to a perijove below Jupiter's cloud tops. The mean burn deltaV of 77 m/s is the largest maneuver of the mission after the 4 main engine maneuvers, and is planned to be performed on RCS (Reaction Control System) thrusters (deltaV to Earth angle, ELA ~ 70 degrees). The timing of the burn is not mission critical; a contingency delayed execution can occur several days around and following apojove if necessary. Impact into Jupiter marks End of Mission (EOM).

Target Name - JUPITER
Mission Phase Start Time - 2018-02-13 (2018-044)
Mission Phase Stop Time - 2018-02-20 (2018-051)

Perijove 37 - 2018-02-20T11:39:44 (2018-051)

Juno Mission Objectives

Juno's science objectives encompass four scientific themes: origin, interior structure, atmospheric composition and dynamics, and polar magnetosphere.
These are based on Appendix E to the New Frontiers Program Plan: Program Level Requirements for the Juno Project (PLRA). Juno addresses science objectives central to three NASA Science divisions: Solar System (Planetary), Earth-Sun System (Heliophysics), and Universe (Astrophysics). Juno's primary science goal of understanding the formation, evolution, and structure of Jupiter is directly related to the conditions in the early solar system, which led to the formation of our planetary system. The mass of Jupiter's solid core and the abundance of heavy elements in the atmosphere discriminate among models for giant planet formation. Juno constrains the core mass by mapping the gravitational field, and measures through microwave sounding the global abundances of oxygen (water) and nitrogen (ammonia). Juno reveals the history of Jupiter by mapping the gravitational and magnetic fields with sufficient resolution to constrain Jupiter's interior structure, the source region of the magnetic field, and the nature of deep convection. By sounding deep into Jupiter's atmosphere, Juno determines to what depth the belts and zones penetrate. Juno provides the first survey and exploration of the three-dimensional structure of

Jupiter's polar magnetosphere. The overall goal of the Juno mission is to improve our understanding of the solar system by understanding the origin and evolution of Jupiter.

Atmospheric Composition

Juno investigates the formation and origin of Jupiter's atmosphere and the potential migration of planets through the measurement of Jupiter's global abundance of oxygen (water) and nitrogen (ammonia).

a) Measure the global O/H ratio (water abundance) in Jupiter's atmosphere.
b) Measure the global N/H ratio (ammonia) in Jupiter's atmosphere.

Atmospheric Structure

Juno investigates variations in Jupiter's deep atmosphere related to meteorology, composition, temperature profiles, cloud opacity, and atmospheric dynamics.

a) Determine microwave opacity as a function of latitude and altitude (pressure).
b) Determine depths of cloud and atmospheric features such as zones, belts, and spots, and map dynamical variations in ammonia and water.
c) Characterize microwave opacity of the polar atmosphere region.

Magnetic Field

Juno investigates the fine structure of Jupiter's magnetic field, providing information on its internal structure and the nature of the dynamo.

a) Map the magnetic field of Jupiter, globally, by direct measurement of the field at close-in radial distances.
b) Determine the magnetic spectrum of the field, providing information on the dynamo core radius.
c) Investigate secular variations (long-term time variability) of the magnetic field.

Gravity Field

Juno gravity sounding explores the distribution of mass inside the planet.

a) Determine the gravity field to provide constraints on the mass of the core.
b) Determine the gravity field to detect the centrifugal response of the planet to its own differential rotation (winds) at depths of kilobars and greater.
c) Investigate the response to tides raised by the Jovian satellites.

Polar Magnetosphere

Juno explores Jupiter's three-dimensional polar magnetosphere and aurorae.

a) Investigate the primary auroral processes responsible for particle acceleration.
b) Characterize the field-aligned currents that transfer angular momentum from Jupiter to its magnetosphere.
c) Identify and characterize auroral radio and plasma wave emissions associated with particle acceleration.
d) Characterize the nature, location, and spatial scale of auroral features.

References

Stephens, S. K., Juno Project Mission Plan, Rev. D, JPL D-35556, 15 August 2013.