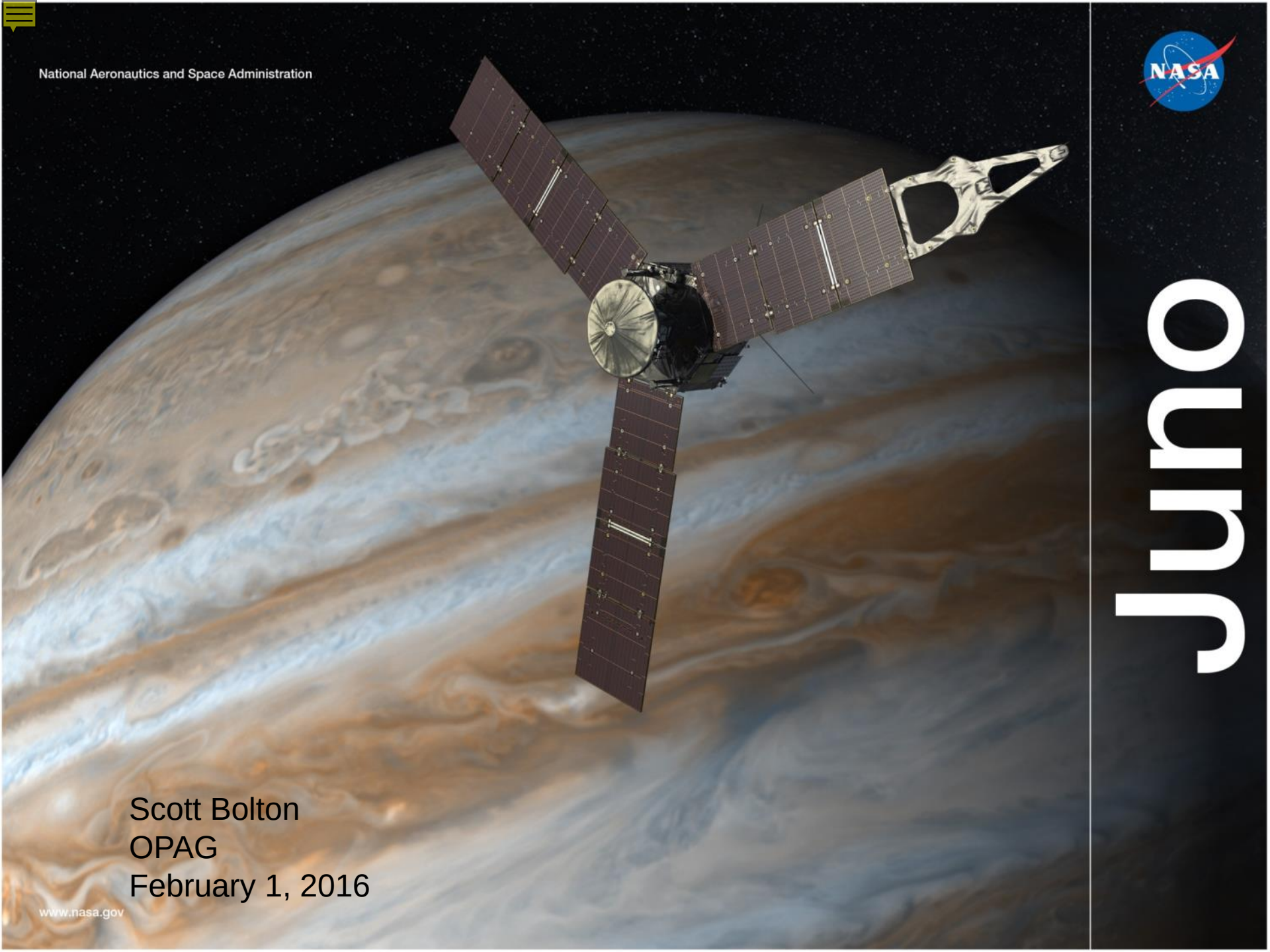

National Aeronautics and Space Administration
NASA
Juno
Scott Bolton
OPAG
February 1, 2016
www.nasa.gov

Juno Status

- Launched August 2011
- Earth flyby October 2013
- Jupiter arrival July 4, 2016
- Spacecraft is healthy and all instruments are working.

Juno Science

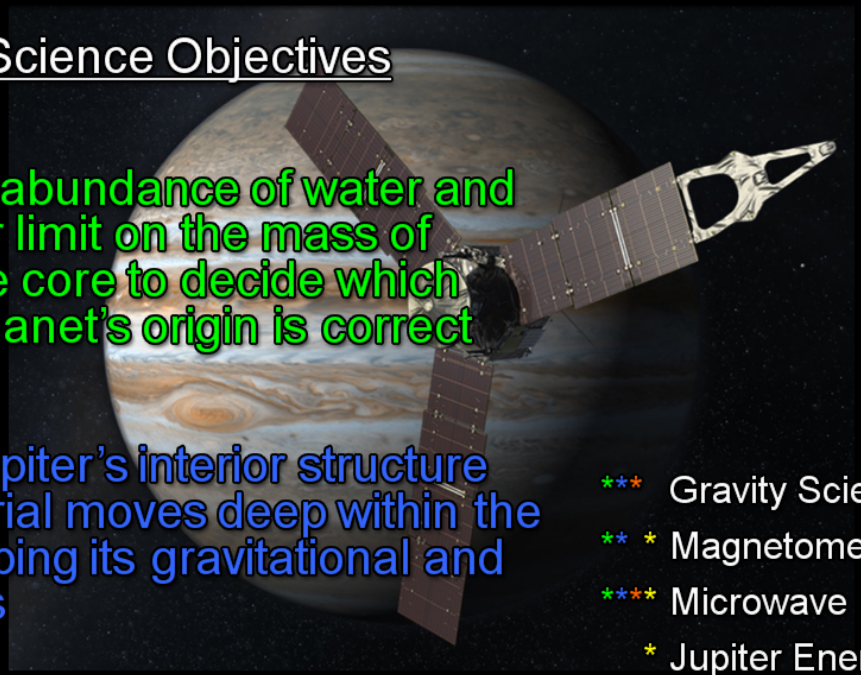
Juno Science Objectives

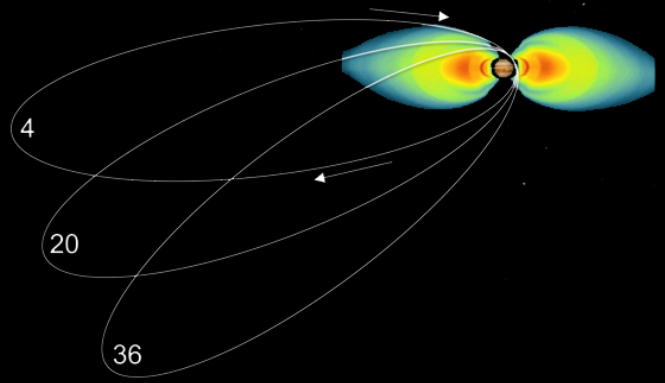
Origin
Determine the abundance of water and place an upper limit on the mass of Jupiter's dense core to decide which theory of the planet's origin is correct

Interior
Understand Jupiter's interior structure and how material moves deep within the planet by mapping its gravitational and magnetic fields

Atmosphere
Map variations in atmospheric composition, temperature, cloud opacity and dynamics to depths greater than 100 bars at all latitudes

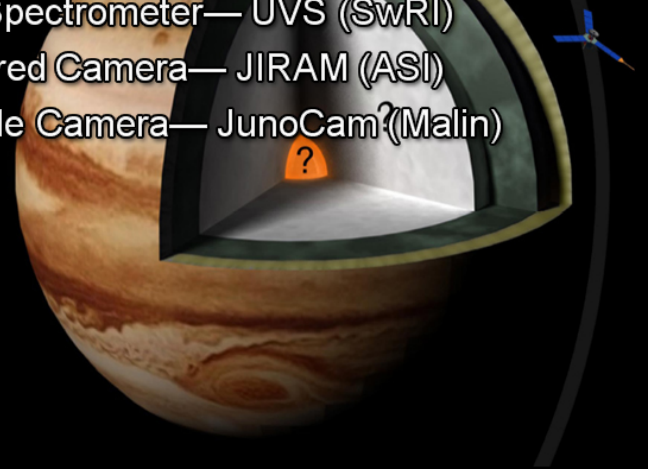
Magnetosphere
Characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras.





Juno Instruments

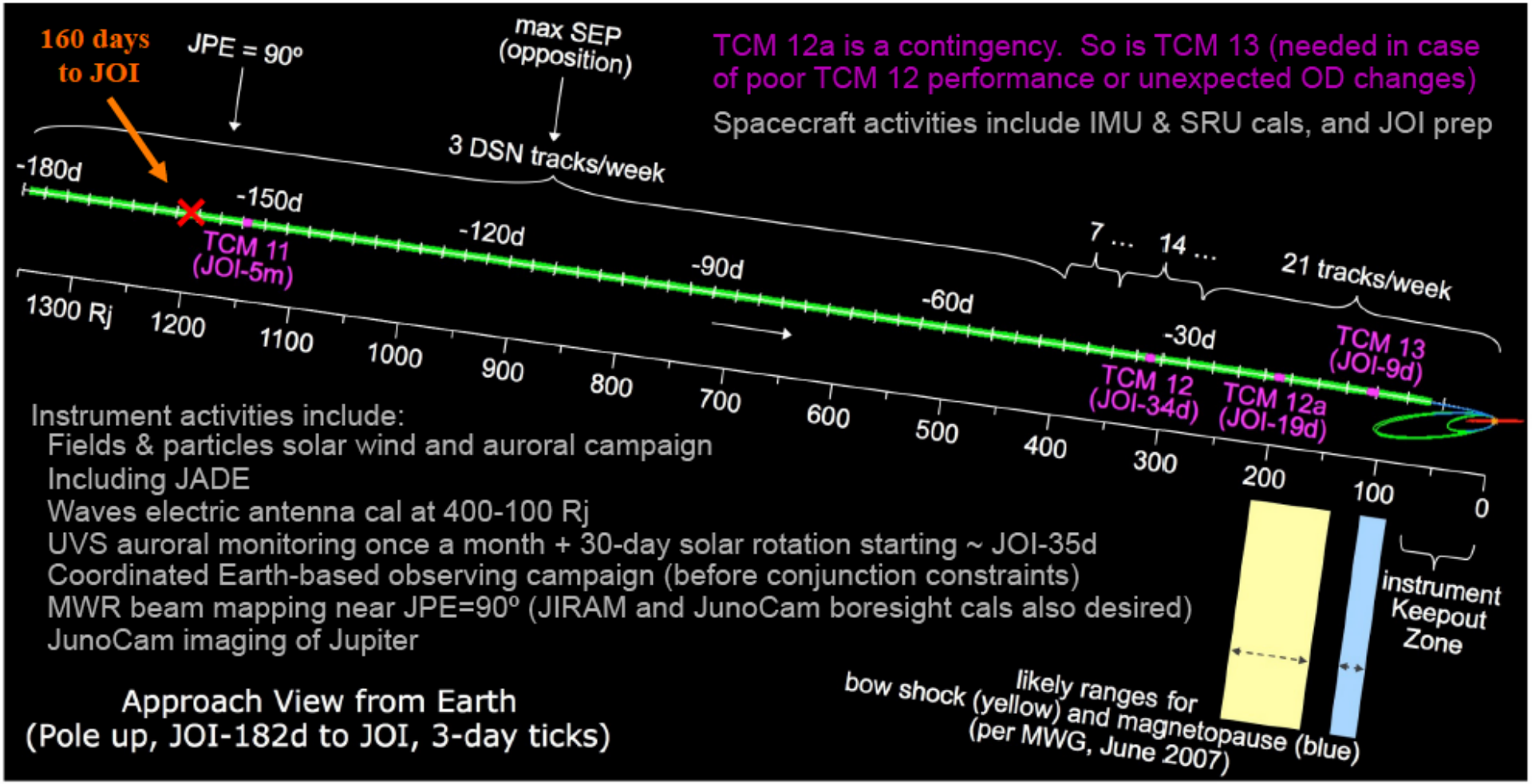
*** Gravity Science (JPL, ASI)
** * Magnetometer— MAG (GSFC)
**** Microwave Radiometer— MWR (JPL)
* Jupiter Energetic Particle Detector— JEDI (APL)
* Jovian Auroral Distributions Exp.— JADE (SwRI)
* Plasma Waves Instrument— Waves (U of Iowa)
* UV Spectrometer— UVS (SwRI)
** Infrared Camera— JIRAM (ASI)
* Visible Camera— JunoCam (Malin)



Spacecraft & Payload

SPACECRAFT DIMENSIONS
Diameter: 80 feet (20 meters)
Height: 15 feet (4.5 meters)

Jupiter Approach



TCM 12a is a contingency. So is TCM 13 (needed in case of poor TCM 12 performance or unexpected OD changes)

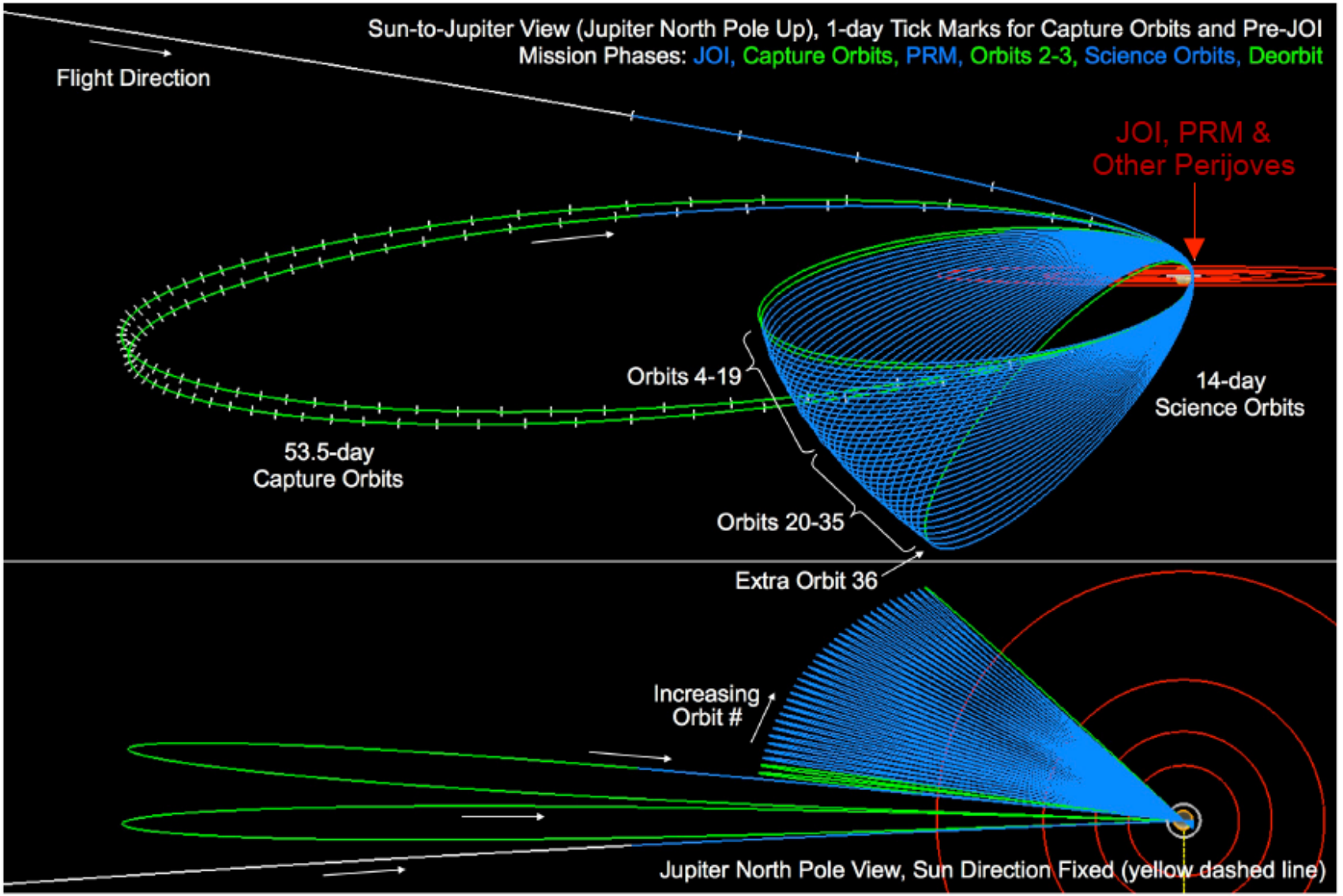
Spacecraft activities include IMU & SRU cals, and JOI prep

Instrument activities include:
- Fields & particles solar wind and auroral campaign
- Including JADE
- Waves electric antenna cal at 400-100 Rj
- UVS auroral monitoring once a month + 30-day solar rotation starting ~ JOI-35d
- Coordinated Earth-based observing campaign (before conjunction constraints)
- MWR beam mapping near JPE=90° (JIRAM and JunoCam boresight cals also desired)
- JunoCam imaging of Jupiter

Approach View from Earth
(Pole up, JOI-182d to JOI, 3-day ticks)

The technical data in this document is controlled under the U.S. Export Regulations; release to foreign persons may require an export authorization

Orbital trajectory

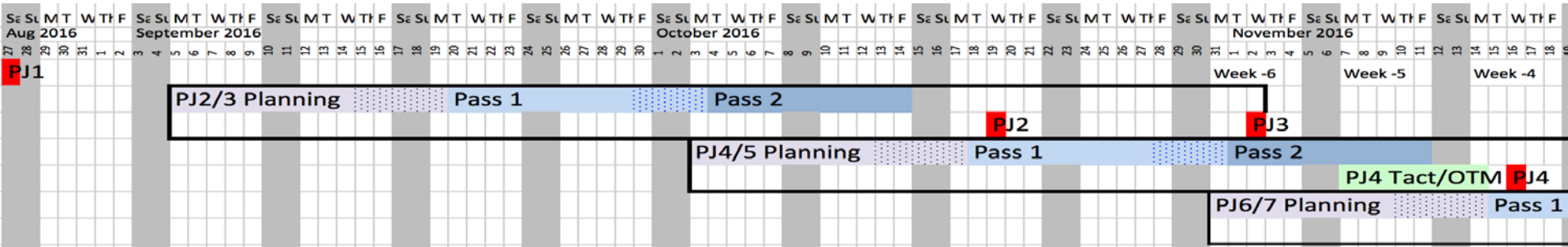


Perijove #	Type
0	JOI
1	Perijove 1
2	PRM
3	PRM Cleanup
4	MWR
5	GRAV
6	MWR
7	MWR
8	MWR Tilt
9	MWR
10	GRAV
11	GRAV
12	GRAV
13	GRAV
14	MWR Tilt
15	GRAV
16	GRAV
17	GRAV
18	GRAV
19	GRAV
20	GRAV
21	GRAV
22	GRAV
23	MWR Tilt
24	GRAV
25	GRAV
26	GRAV
27	GRAV
28	GRAV
29	GRAV
30	GRAV
31	GRAV
32	GRAV
33	GRAV
34	GRAV
35	GRAV
36	Extra (GRAV)
37	Deorbit

The technical data in this document is controlled under the U.S. Export Regulations; release to foreign persons may require an export authorization

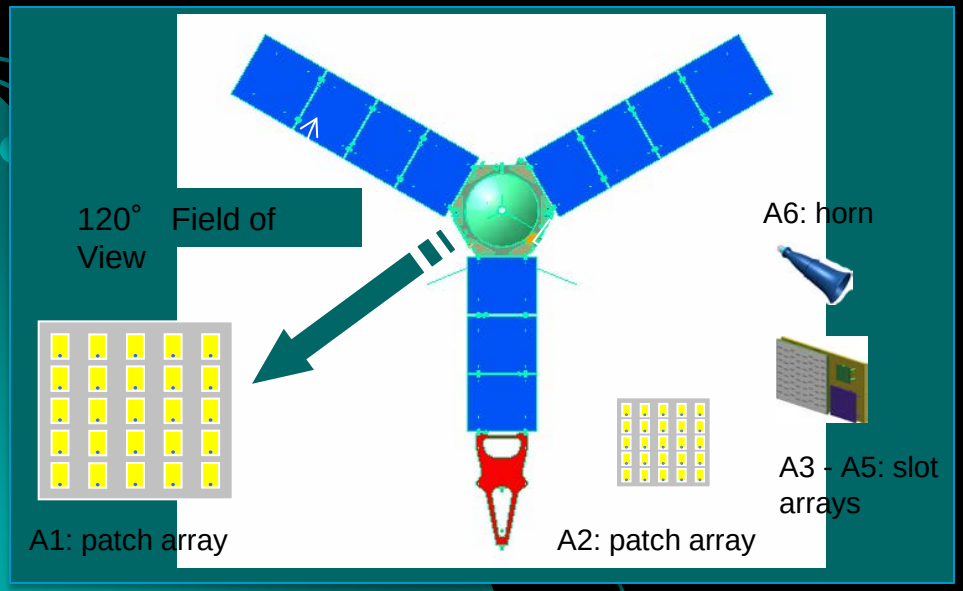
Science Activity By Perijove

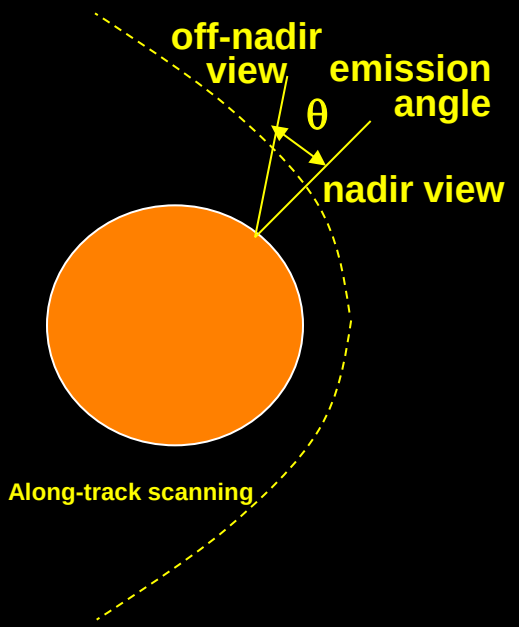
- **Perijove 0**: JOI. Instruments off, no science.
- **Perijove 1**: Instruments on, without KaT. First look at how Jupiter will surprise us. Extra longitude beyond original longitude map.
- **Perijove 2**: PRM. MWR, ASC, and FGM on. Extra longitude beyond original longitude map. Unique attitude and spin rate.
- **Perijove 3**: PRM cleanup (thrusters). Instruments on. Extra longitude beyond original longitude map.
- **Perijove 4–35**: Primary science orbits. 32 longitudes, spaced properly for magnetic mapping.
- **Perijove 36**: Spare orbit, to fill in missing longitude if necessary.



Microwave Radiometer (MWR) Experiment

The microwave antennas are distributed around the spacecraft and view perpendicular to the spacecraft spin axis



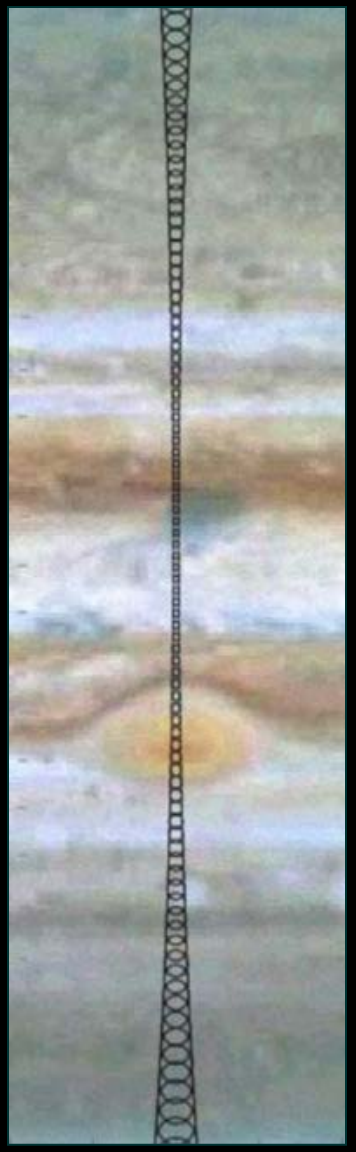


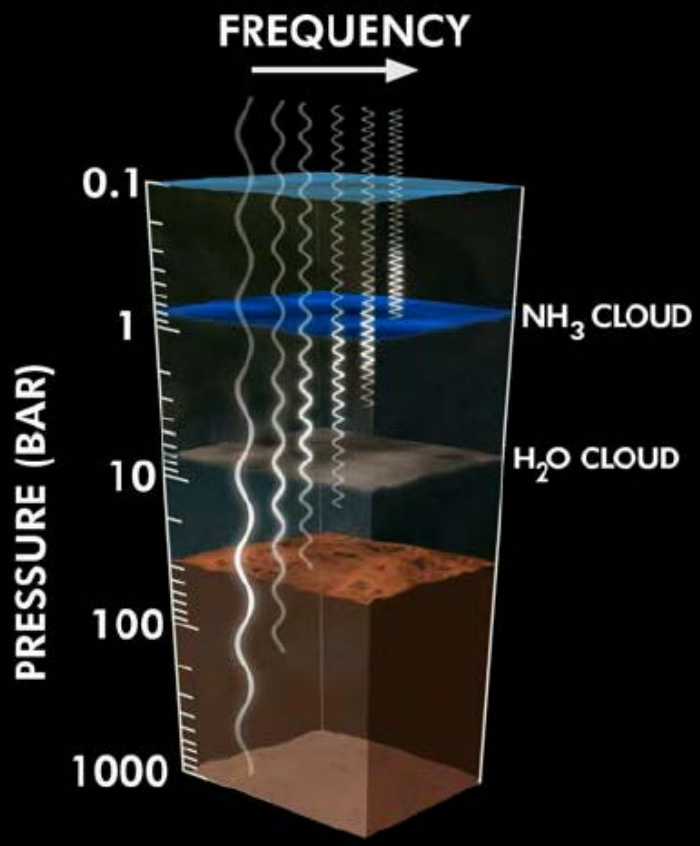
Sensing the deep atmosphere

Juno's Microwave Radiometer measures thermal radiation from the atmosphere

1000 atmospheres pressure (~500-600km below the visible cloud tops).

Determines water and ammonia abundances in the atmosphere all over the planet

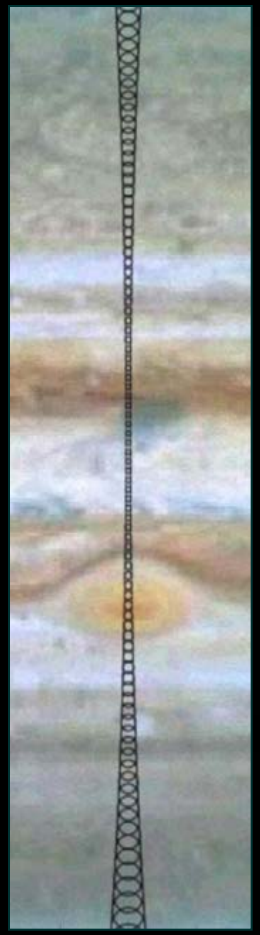


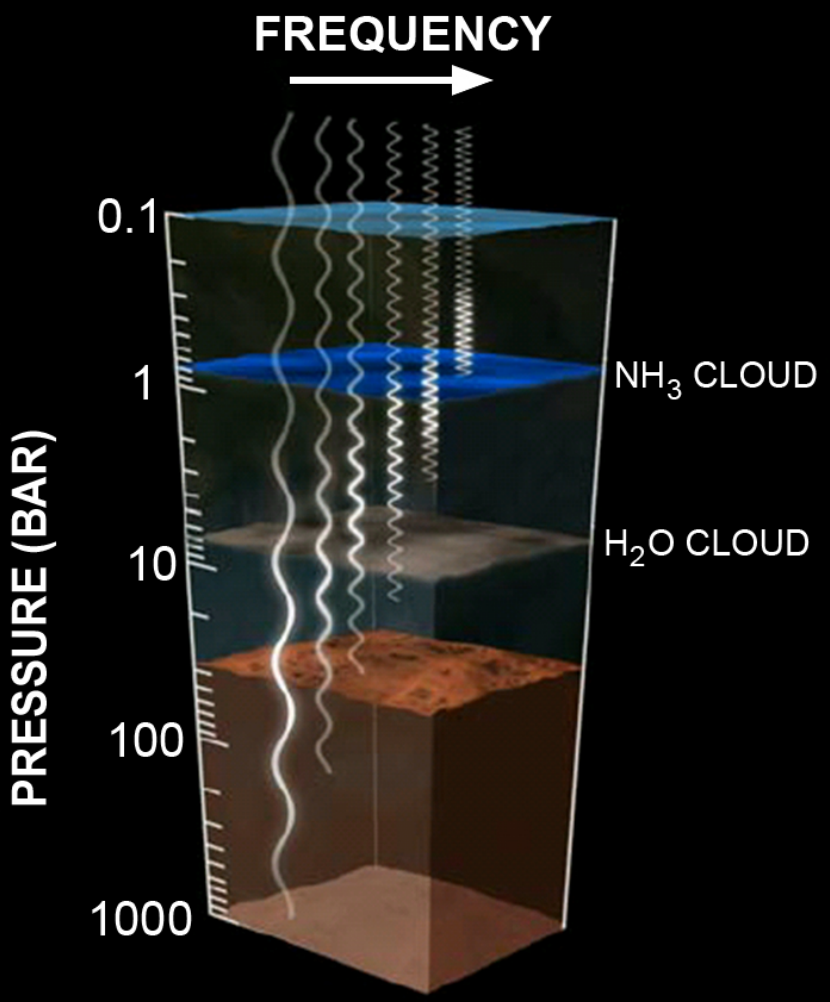


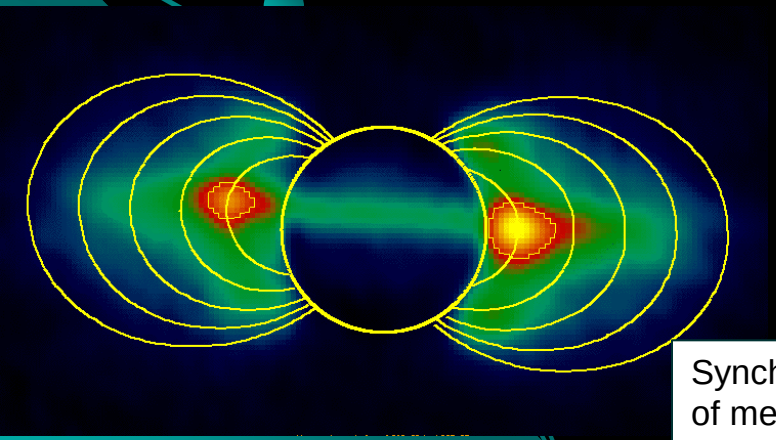
Sensing the deep atmosphere

Juno's Microwave Radiometer measures thermal radiation from the atmosphere to as deep as 1000 atmospheres pressure (~500-600 km below the visible cloud tops).

Determines water and ammonia abundances in the atmosphere all over the planet





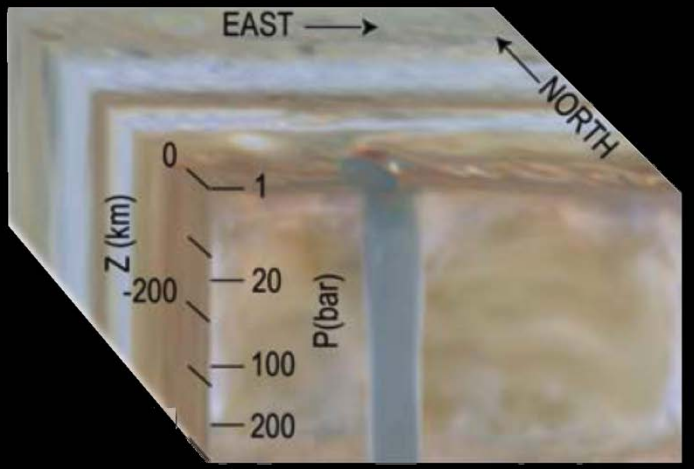


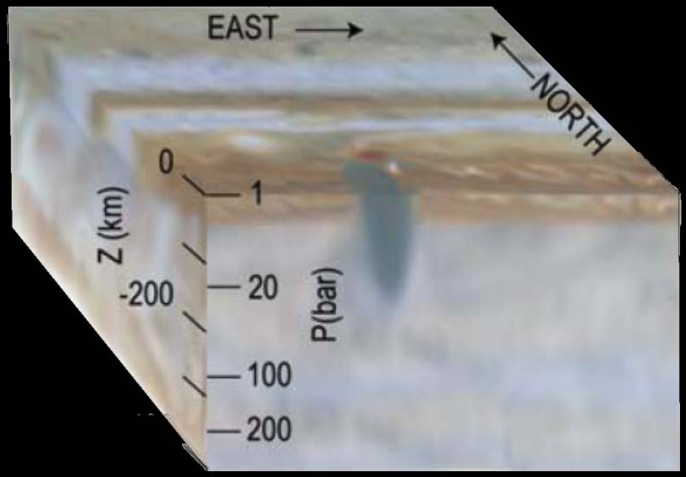
Synchrotron radio emission from the radiation belts makes this kind of measurement impossible from Earth

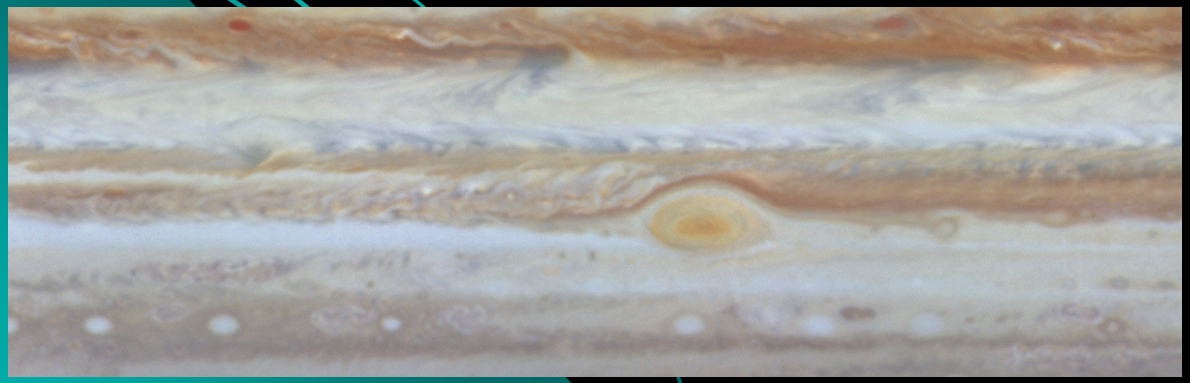
Atmospheric Dynamics

Radiometry investigates atmospheric structure

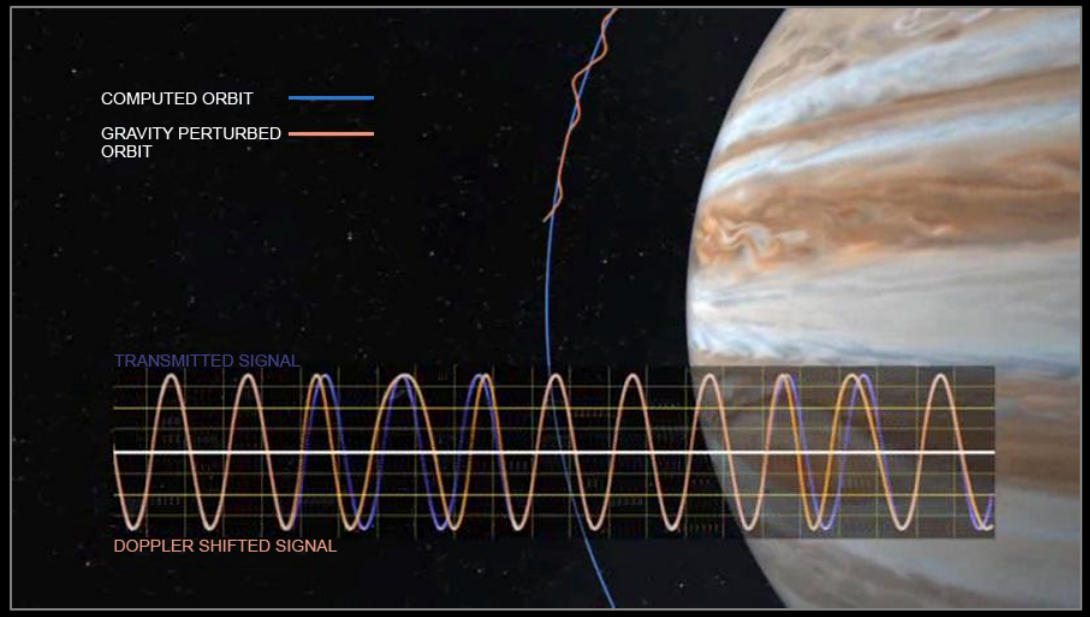
Gravity investigates differential rotation







Mapping Jupiter's gravity

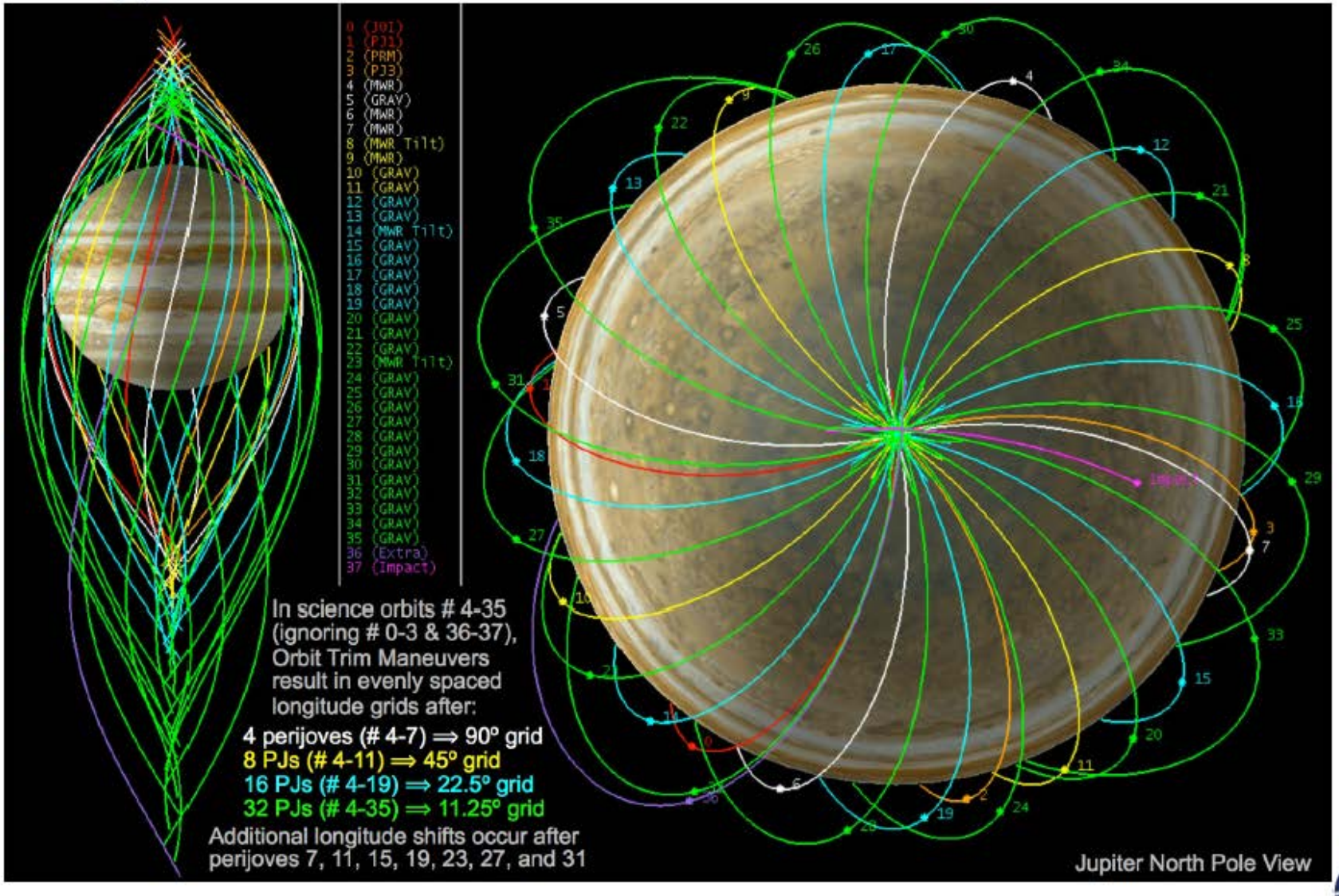


Tracking changes in Juno's velocity reveals Jupiter's gravity (and how the planet is arranged on the inside).

Precise Doppler measurements of spacecraft motion reveal the gravity field.

Tides provide further clues.

Global magnetic field net (including JOI and PRM trajectories)



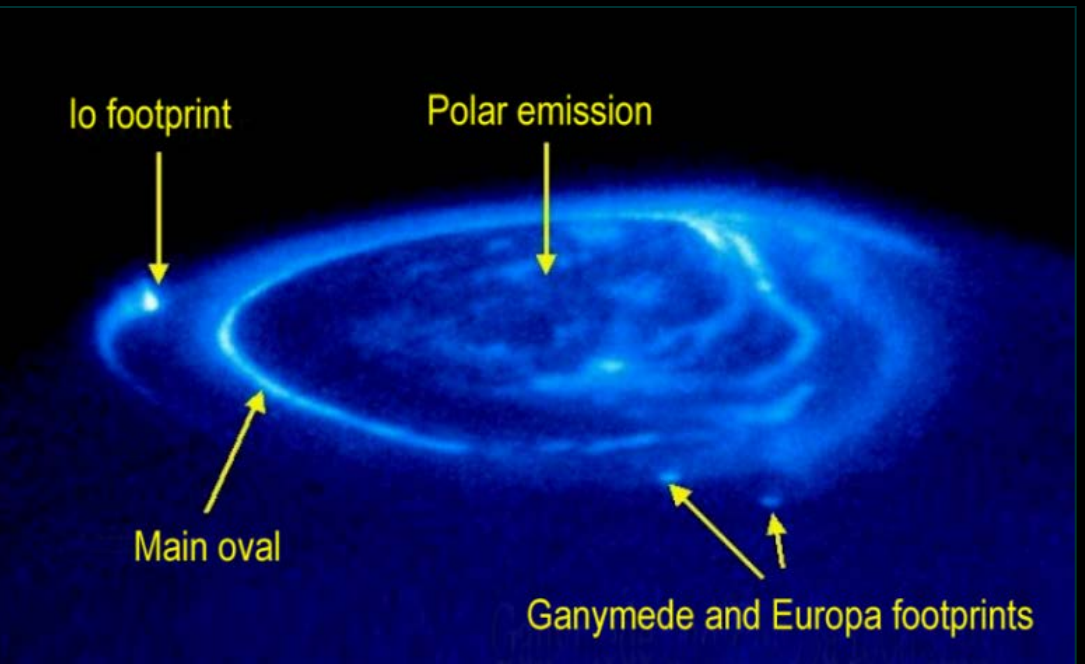
The technical data in this document is controlled under the U.S. Export Regulations; release to foreign persons may require an export authorization

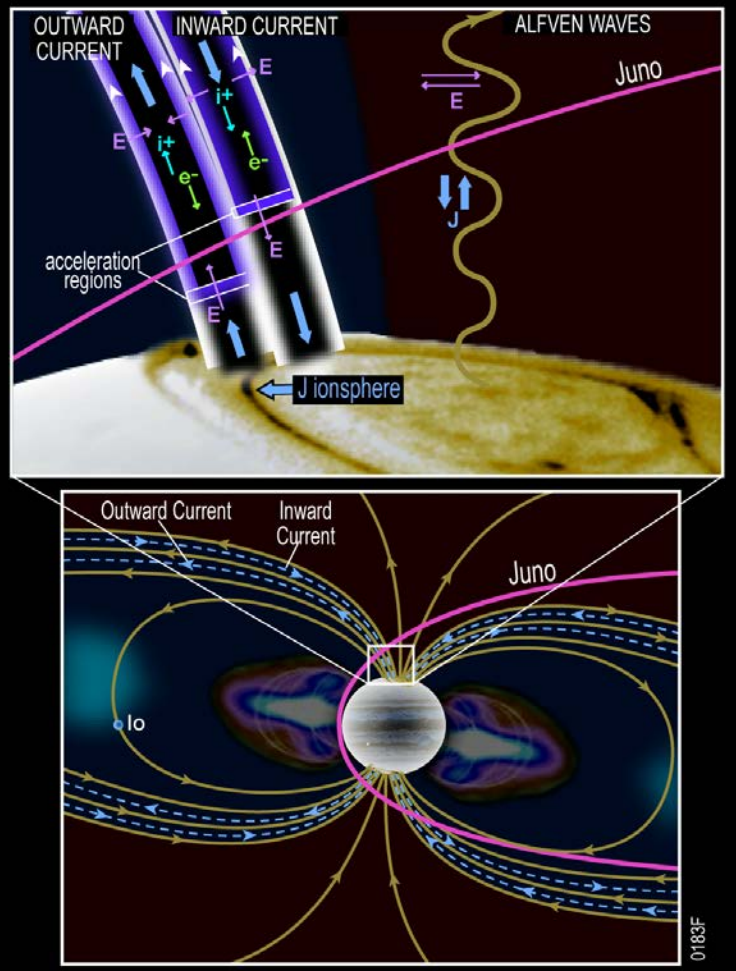
Polar Magnetosphere Exploration

Location is Key: Juno passes directly through auroral field lines.

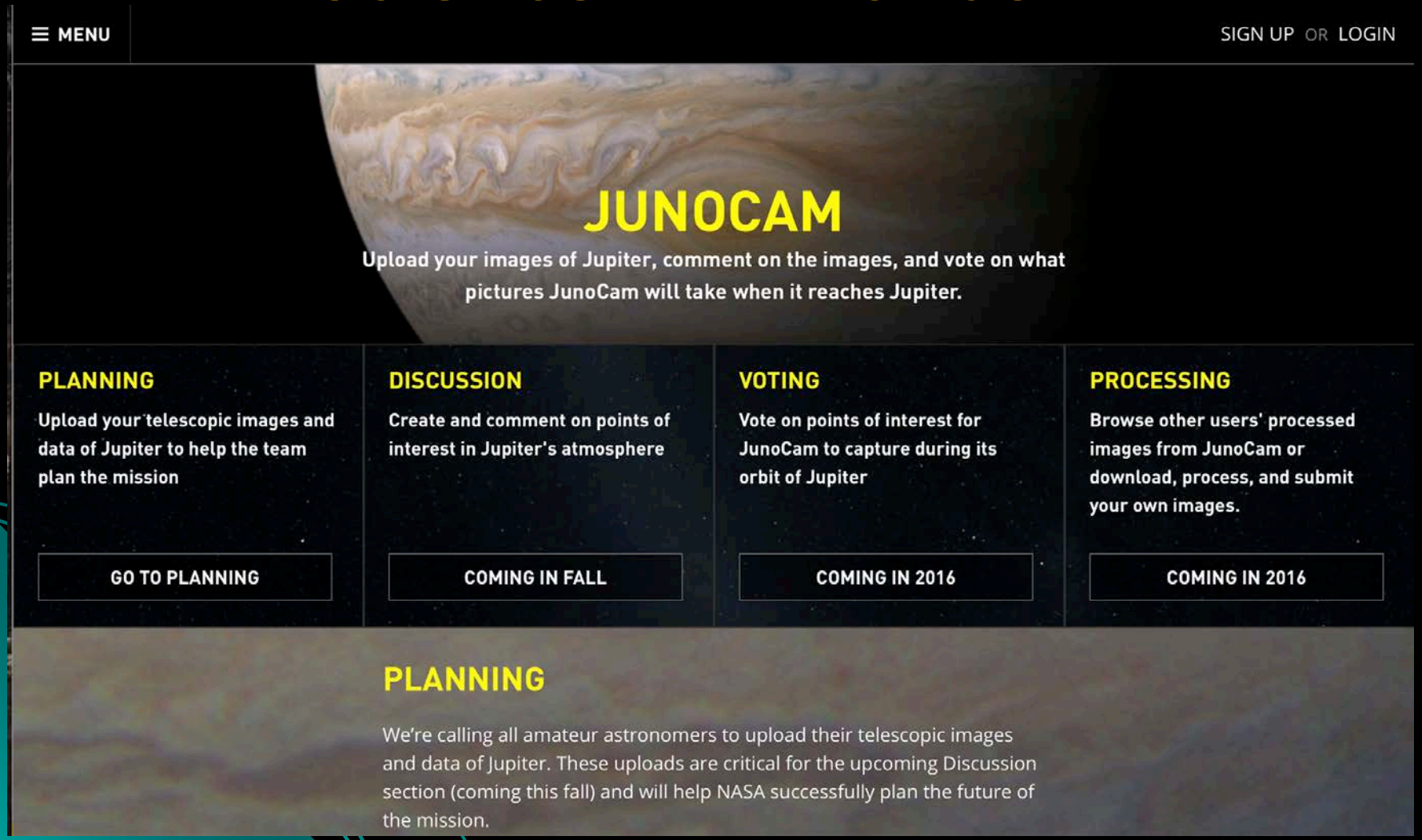
A suite of instruments are used to understand the physics:

JADE, JEDI, MAG, Waves, JIRAM, UVS





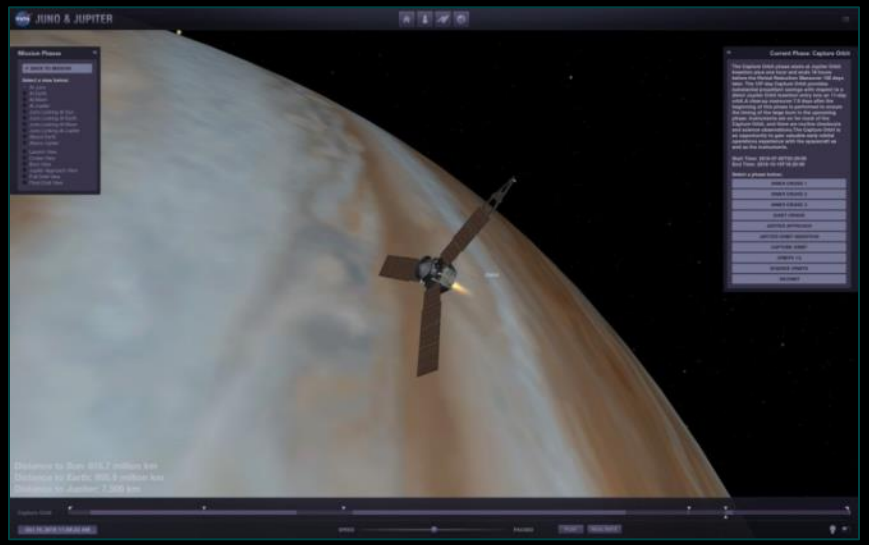
“Science In A Fishbowl”



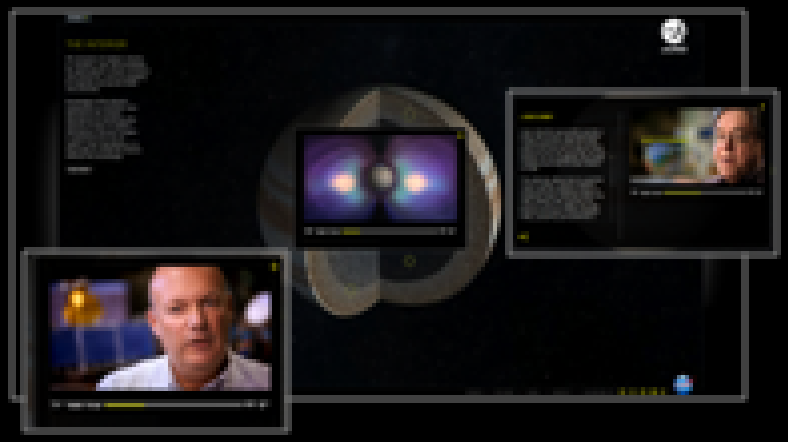
http://missionjuno.swri.edu click on “Junocam”

Fly along with Juno

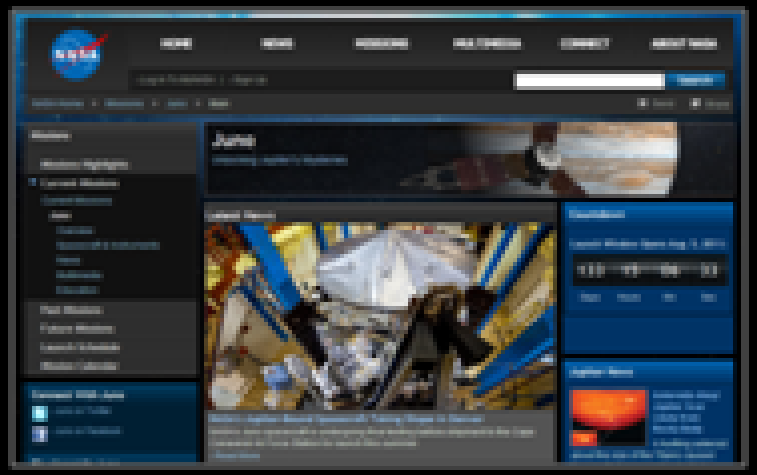
Juno is part of NASA's 3D interactive, ***Eyes on the Solar System***…



For more information...

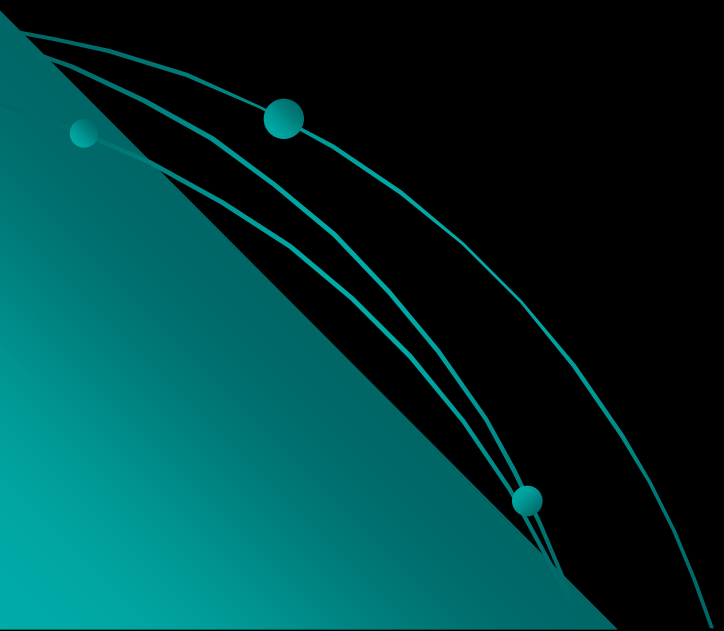


http://missionjuno.swri.edu

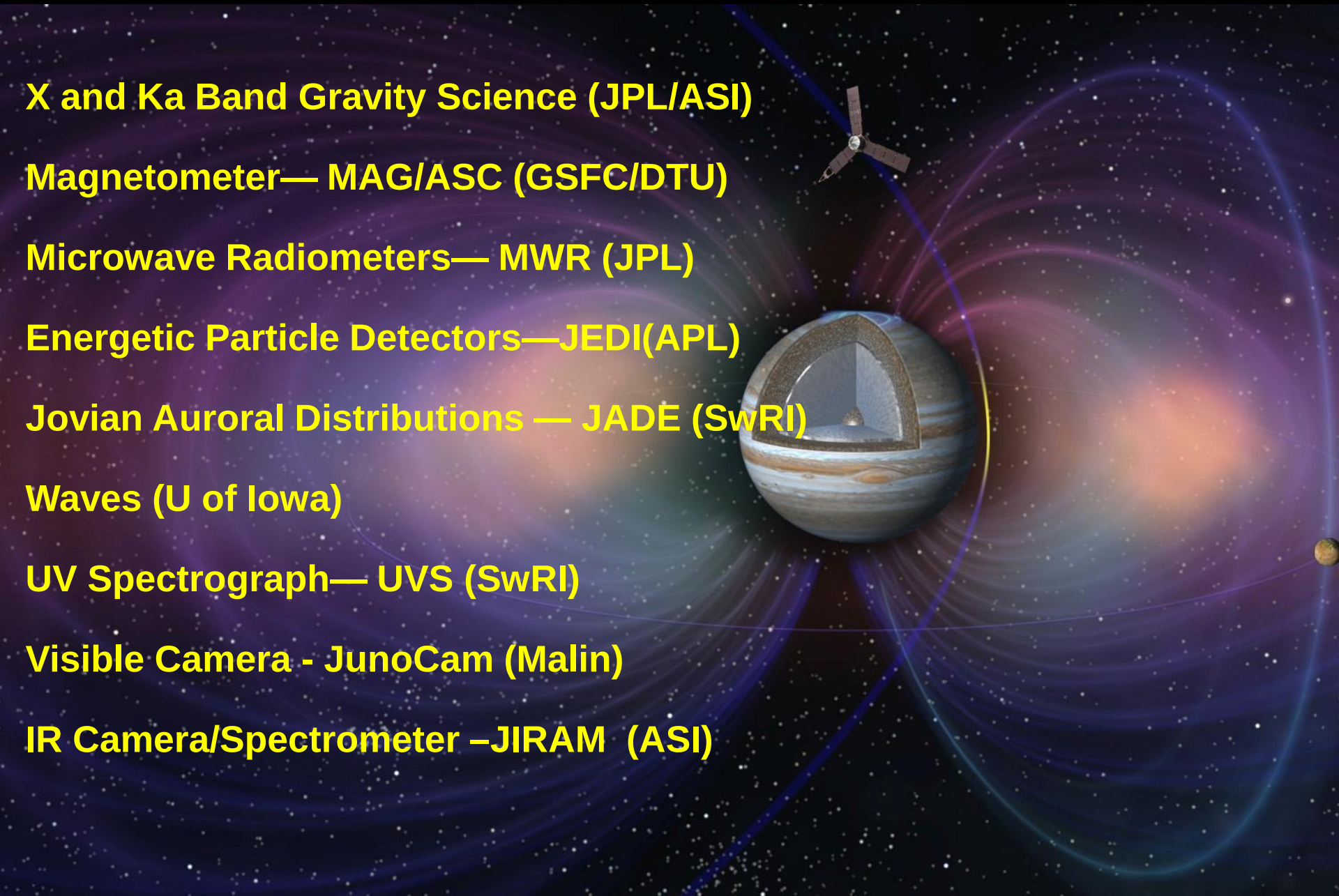


http://www.nasa.gov/juno

backup



Juno Payload



X and Ka Band Gravity Science (JPL/ASI)

Magnetometer— MAG/ASC (GSFC/DTU)

Microwave Radiometers— MWR (JPL)

Energetic Particle Detectors—JEDI(APL)

Jovian Auroral Distributions — JADE (SwRI)

Waves (U of Iowa)

UV Spectrograph— UVS (SwRI)

Visible Camera - JunoCam (Malin)

IR Camera/Spectrometer –JIRAM (ASI)

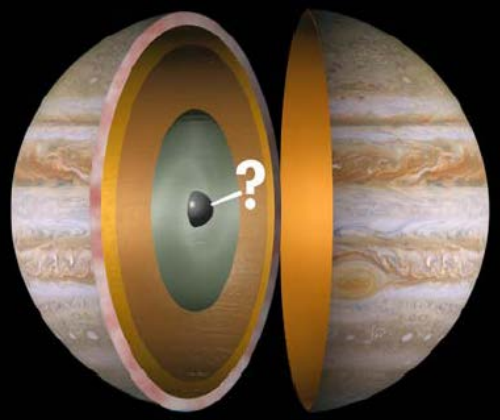
Juno's Science Objectives

Origin

Determine O/H ratio (water abundance) and constrain core mass to decide among alternative theories of origin.

Interior

Understand Jupiter's interior structure and dynamical properties by mapping its gravitational and magnetic fields

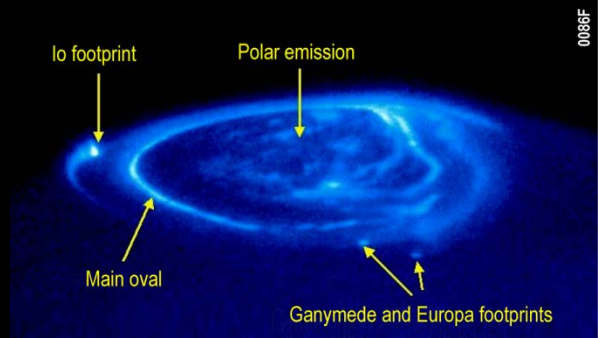


Atmosphere

Map variations in atmospheric composition, temperature, cloud opacity and dynamics to depths greater than 100 bars at all latitudes.

Magnetosphere

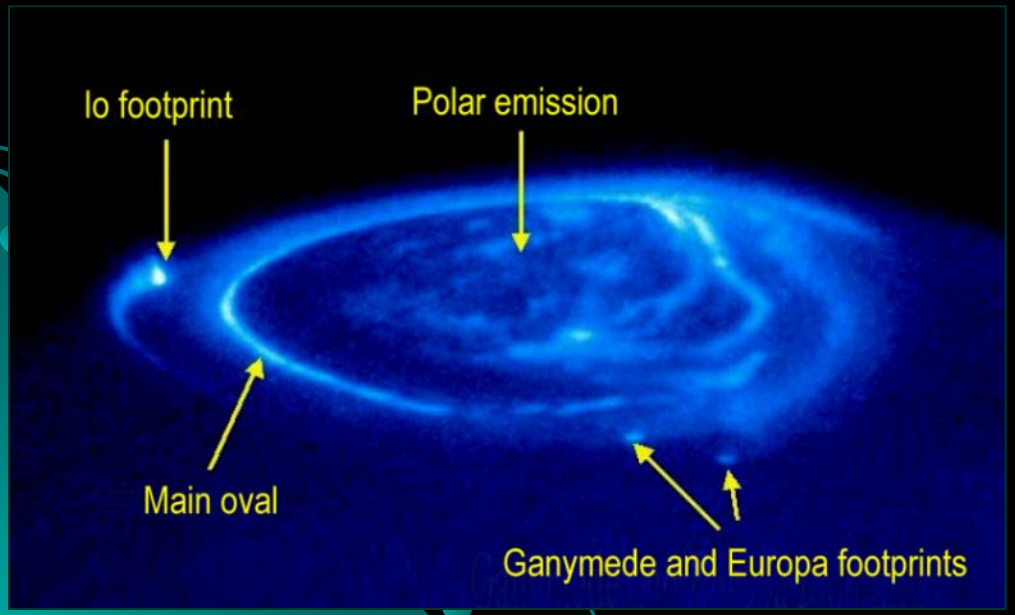
Characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras.

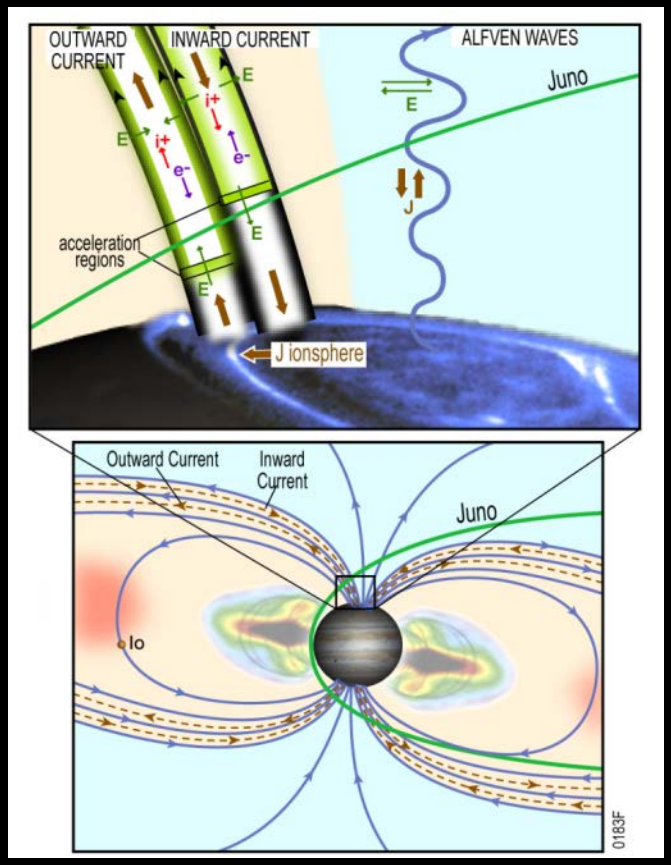


Exploring the Polar Magnetosphere

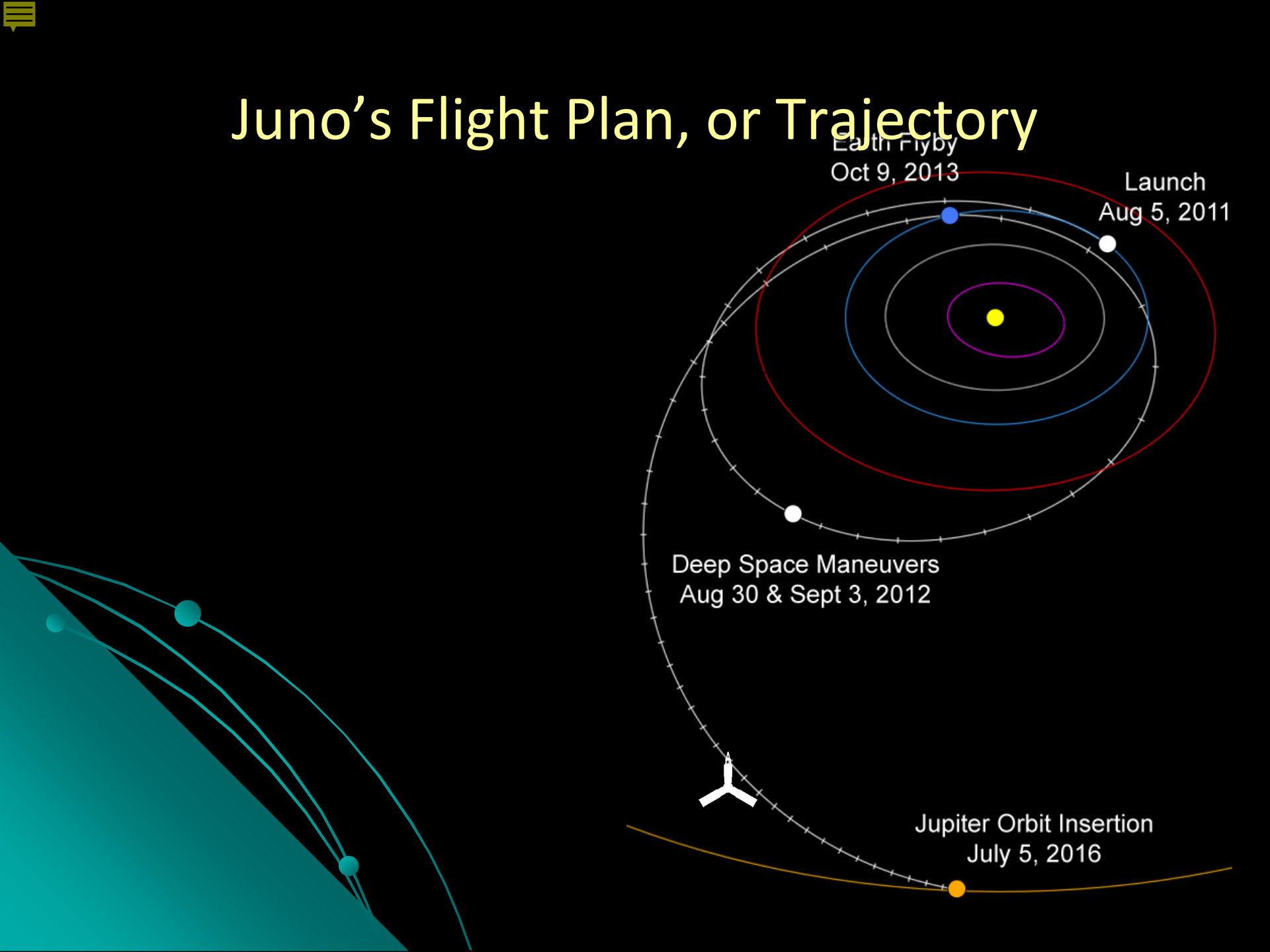
Jupiter's magnetosphere near the planet's poles is a completely unexplored region!

Juno's investigation will provide new insights about how the planet's enormous magnetic force field generates the aurora.





Juno's Flight Plan, or Trajectory



Juno Mission Overview

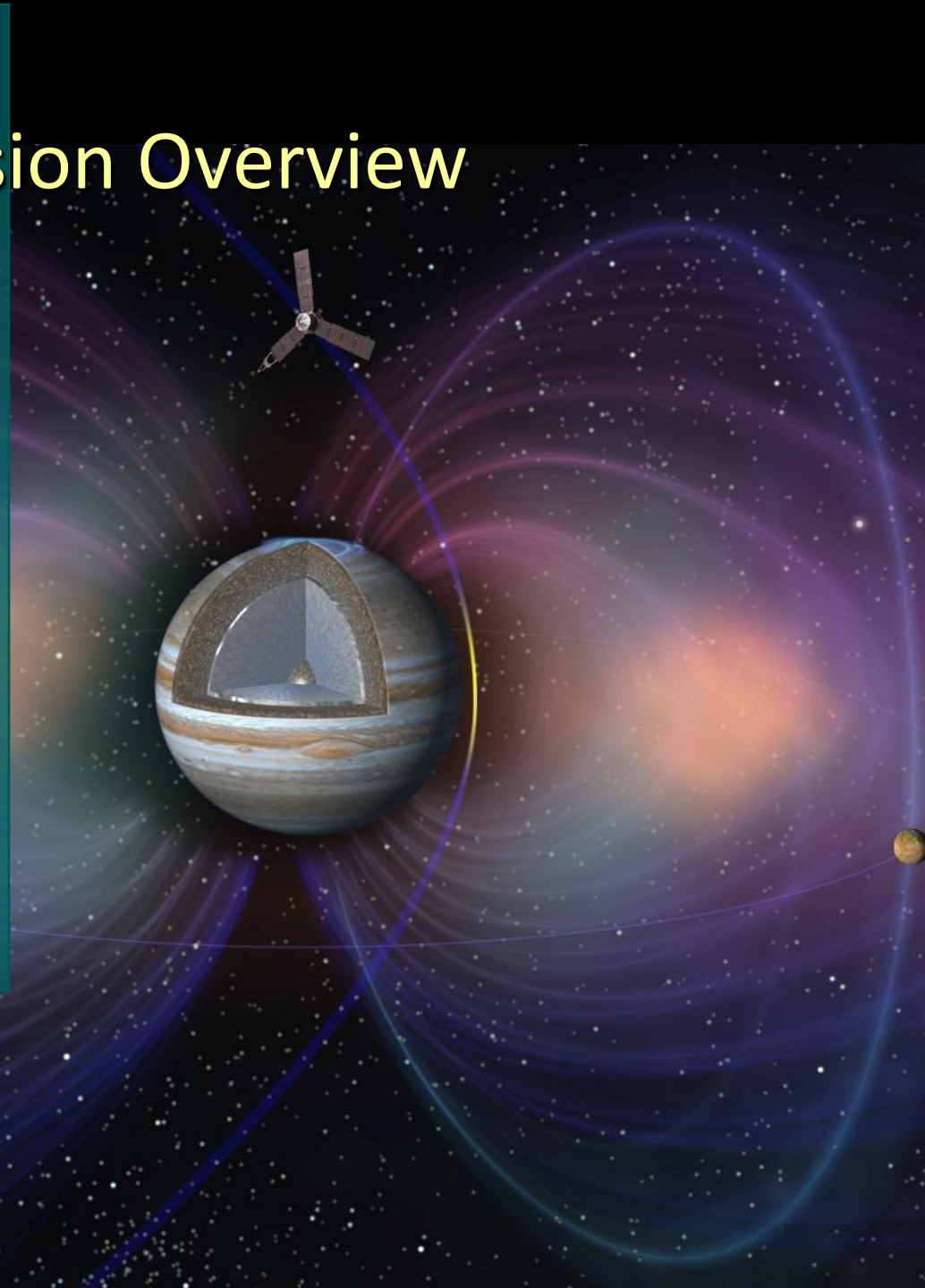
Salient Features:

- First solar-powered mission to Jupiter
- Eight science instruments to conduct gravity, magnetic and atmospheric investigations plus a camera for education and public outreach
- Spinning, polar orbiter spacecraft launched on August 5, 2011
  - 5-year cruise to Jupiter, arriving July 2016
  - About 1 year at Jupiter, ending with de-orbit into Jupiter in 2017
- Elliptical 11-day orbit swings below radiation belts to minimize radiation exposure
- 2nd mission in NASA's New Frontiers Program

Science Objective: Improve our understanding of giant planet formation and evolution by studying Jupiter's origin, interior structure, atmospheric composition and dynamics, and magnetosphere

Principal Investigator: Scott Bolton

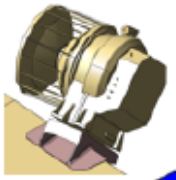
Southwest Research Institute



Instrument Suite

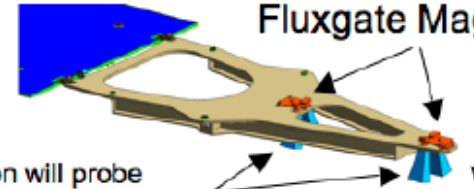
Payload = 8 science instruments + JunoCam E/PO investigation, (total 26 sensors)

Jovian Auroral Distributions Experiment (JADE)(4)



JADE will measure the distribution of electrons and the velocity distribution and composition of ions.

Fluxgate Magnetometer (FGM)(2)



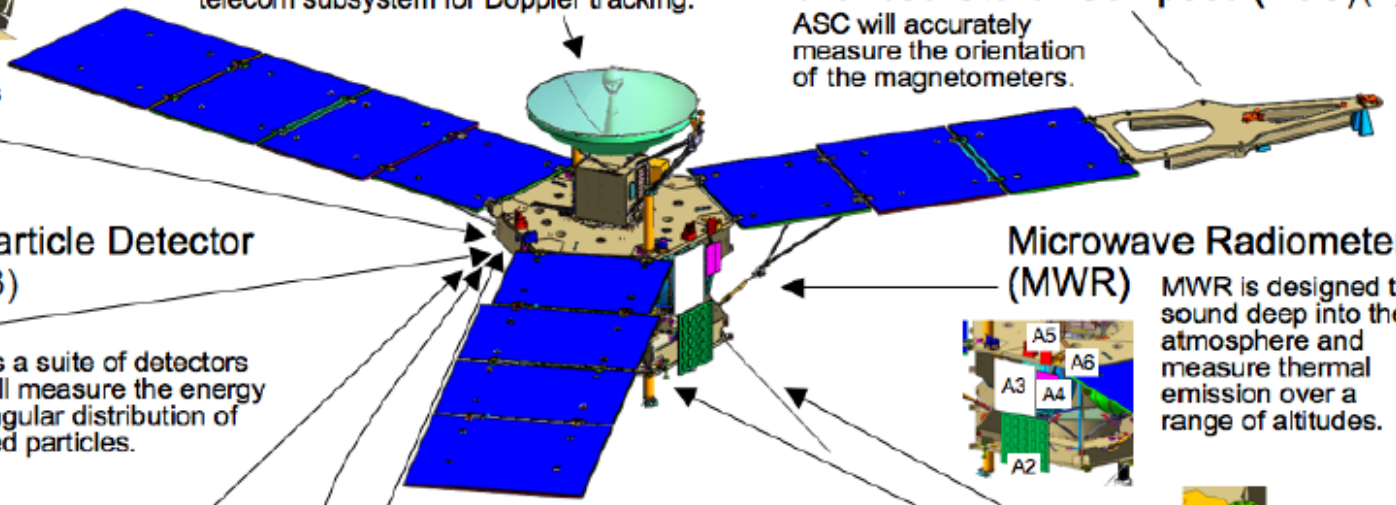
Two FGM sensors will measure the magnitude and direction of the Jovian magnetic field.

Gravity Science (GRAV)(2)

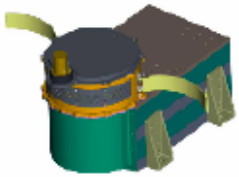
The Gravity Science investigation will probe the mass properties of Jupiter by using the telecom subsystem for Doppler tracking.

Advanced Stellar Compass (ASC)(4)

ASC will accurately measure the orientation of the magnetometers.



Jupiter Energetic-particle Detector Instrument (JEDI)(3)



JEDI is a suite of detectors that will measure the energy and angular distribution of charged particles.

Microwave Radiometer (6) (MWR)

MWR is designed to sound deep into the atmosphere and measure thermal emission over a range of altitudes.

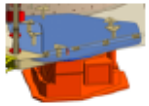
Ultraviolet Spectrograph (UVS)(1)

UVS is an imaging spectrograph that is sensitive to ultraviolet emissions.

JunoCam(1)

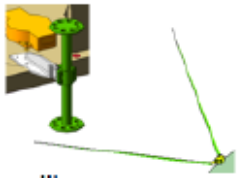
JunoCam will provide visible-color images of the Jovian cloud tops.

Jovian Infrared Auroral Mapper (JIRAM)(1)



JIRAM (on aft deck) will acquire infrared images and spectra of Jupiter.

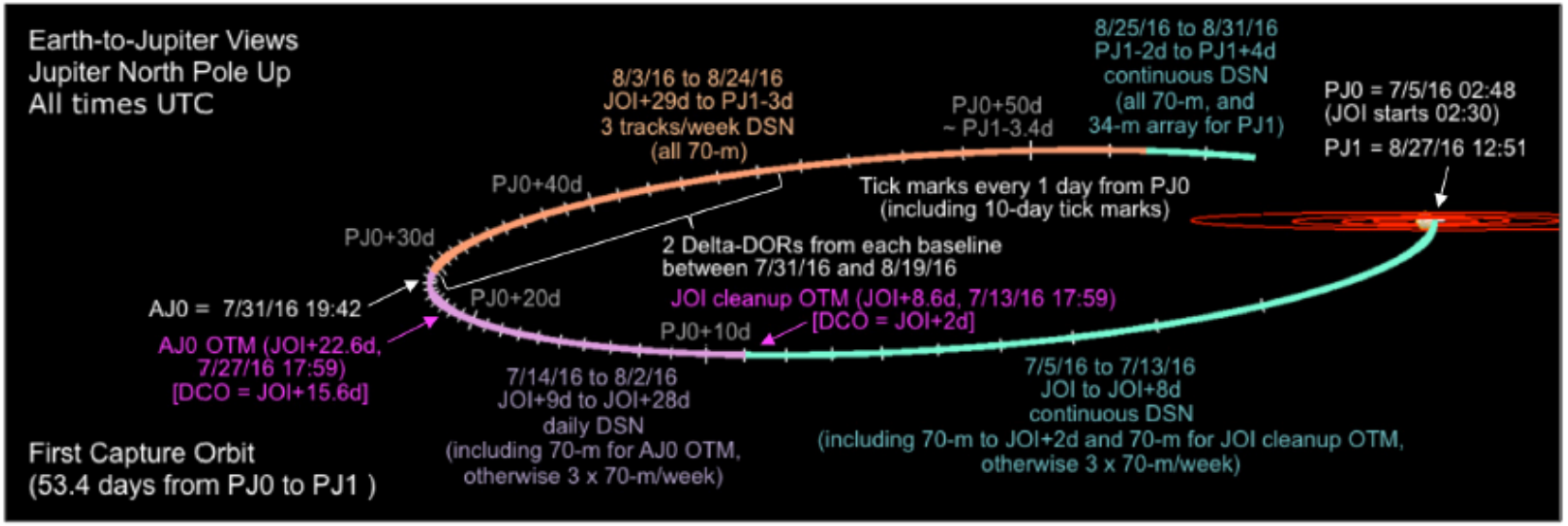
Waves (2)

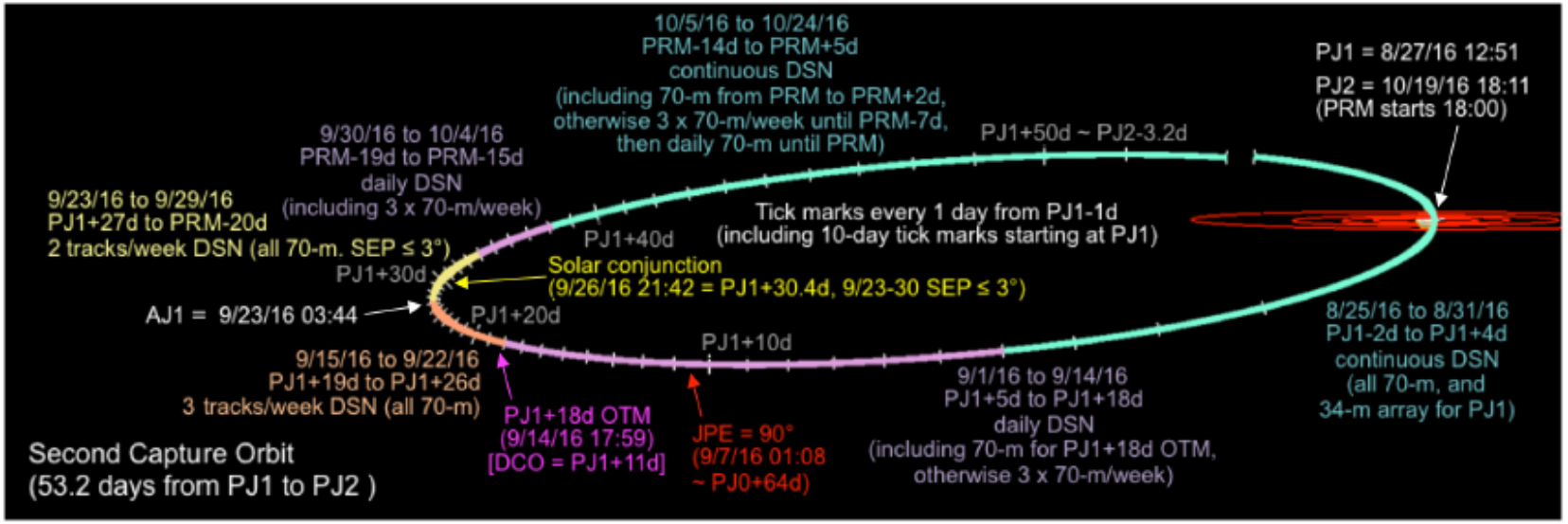


Waves will measure plasma waves and radio waves in Jupiter's magnetosphere.

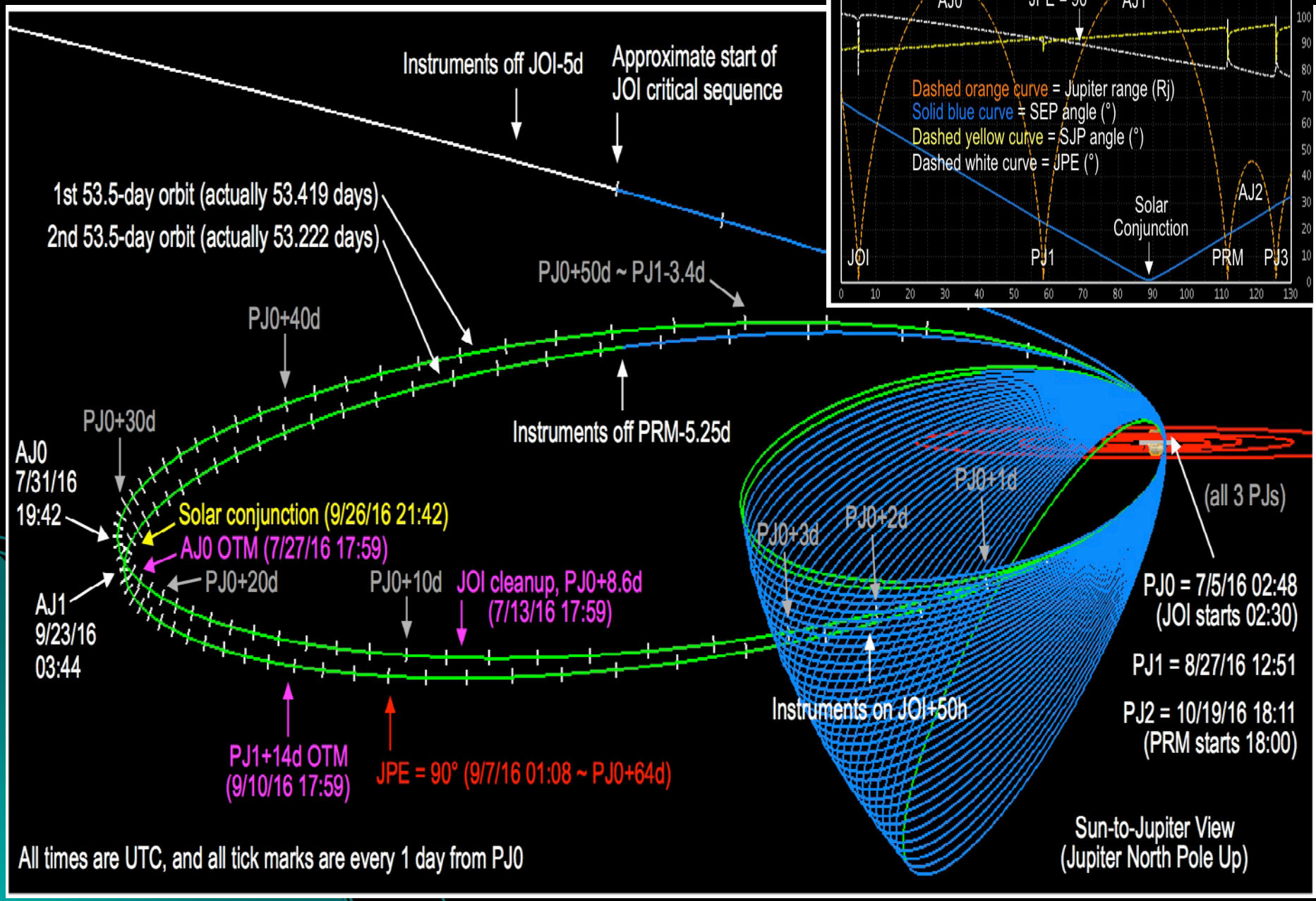
The technical data in this document is controlled under the U.S. Export Regulations; release to foreign persons may require an export authorization

DSN coverage during capture orbits

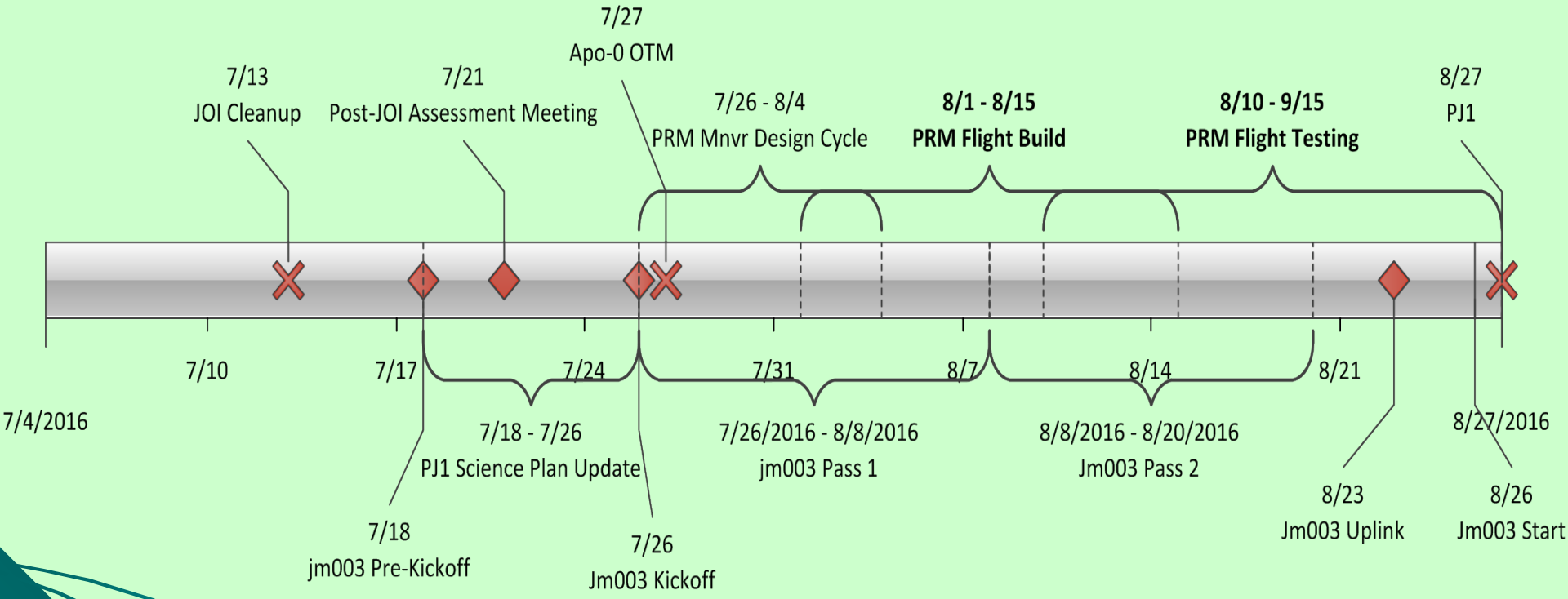




The technical data in this document is controlled under the U.S. Export Regulations; release to foreign persons may require an export authorization


Capture Orbits Range (Rj), SEP/SJP/JPE (deg) (vs days > PJ0-5d)
AJ0
JPE = 90°
AJ1
Dashed orange curve = Jupiter range (Rj)
Solid blue curve = SEP angle (°)
Dashed yellow curve = SJP angle (°)
Dashed white curve = JPE (°)
Solar Conjunction
AJ2
JOI
PJ1
PRM
PJ3
Instruments off JOI-5d
Approximate start of JOI critical sequence
1st 53.5-day orbit (actually 53.419 days)
2nd 53.5-day orbit (actually 53.222 days)
PJ0+50d ~ PJ1-3.4d
PJ0+40d
PJ0+30d
Instruments off PRM-5.25d
AJ0 7/31/16 19:42
Solar conjunction (9/26/16 21:42)
AJ0 OTM (7/27/16 17:59)
PJ0+20d
PJ0+10d
JOI cleanup, PJ0+8.6d (7/13/16 17:59)
AJ1 9/23/16 03:44
PJ1+14d OTM (9/10/16 17:59)
JPE = 90° (9/7/16 01:08 ~ PJ0+64d)
PJ0+1d
PJ0+2d
PJ0+3d
(all 3 PJs)
PJ0 = 7/5/16 02:48 (JOI starts 02:30)
PJ1 = 8/27/16 12:51
PJ2 = 10/19/16 18:11 (PRM starts 18:00)
Instruments on JOI+50h
Sun-to-Jupiter View (Jupiter North Pole Up)
All times are UTC, and all tick marks are every 1 day from PJ0

JOI to PJ1 Timeline



5 Days — Time from JOI Cleanup to Start of PJ1 Sequence Planning

13 Days — Time from JOI Cleanup to End of PJ1 Sequence Planning

17 Days — Time from JOI to Assessment Review

14 Days — Time from JOI Cleanup to Apo-0 OTM

4 Days — Time from Apo-0 OTM to start of PRM Flight Build

PJ1 to PRM Timeline