National Aeronautics and Space Administration
Goddard Space Flight Center

The Juno Mission to Jupiter

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Jet Propulsion Laboratory,
California Institute of Technology,
United States

Juno Science Objectives

Origin

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

Interior

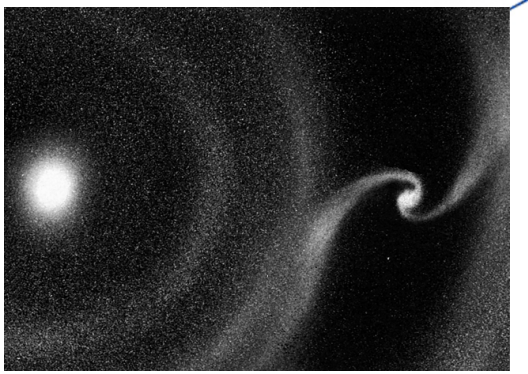
Understand Jupiter's interior structure and dynamical properties by mapping its gravitational and magnetic fields

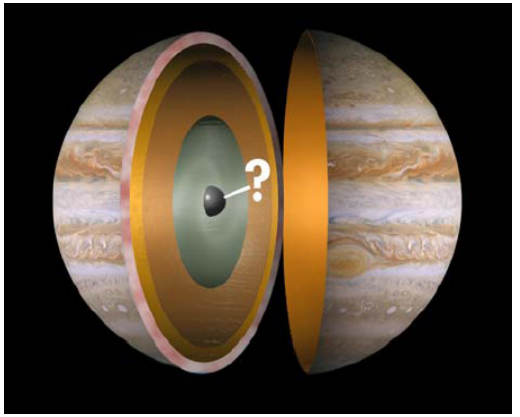
Atmosphere

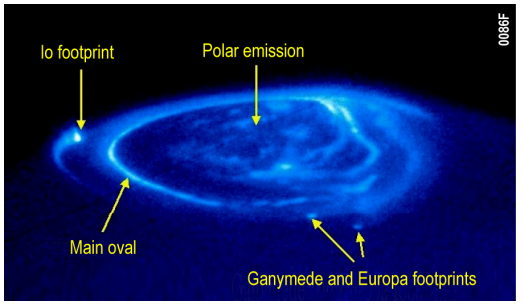
Map variations in atmospheric composition, temperature, cloud opacity and dynamics to depths greater than 100 bars at all latitudes.

Magnetosphere

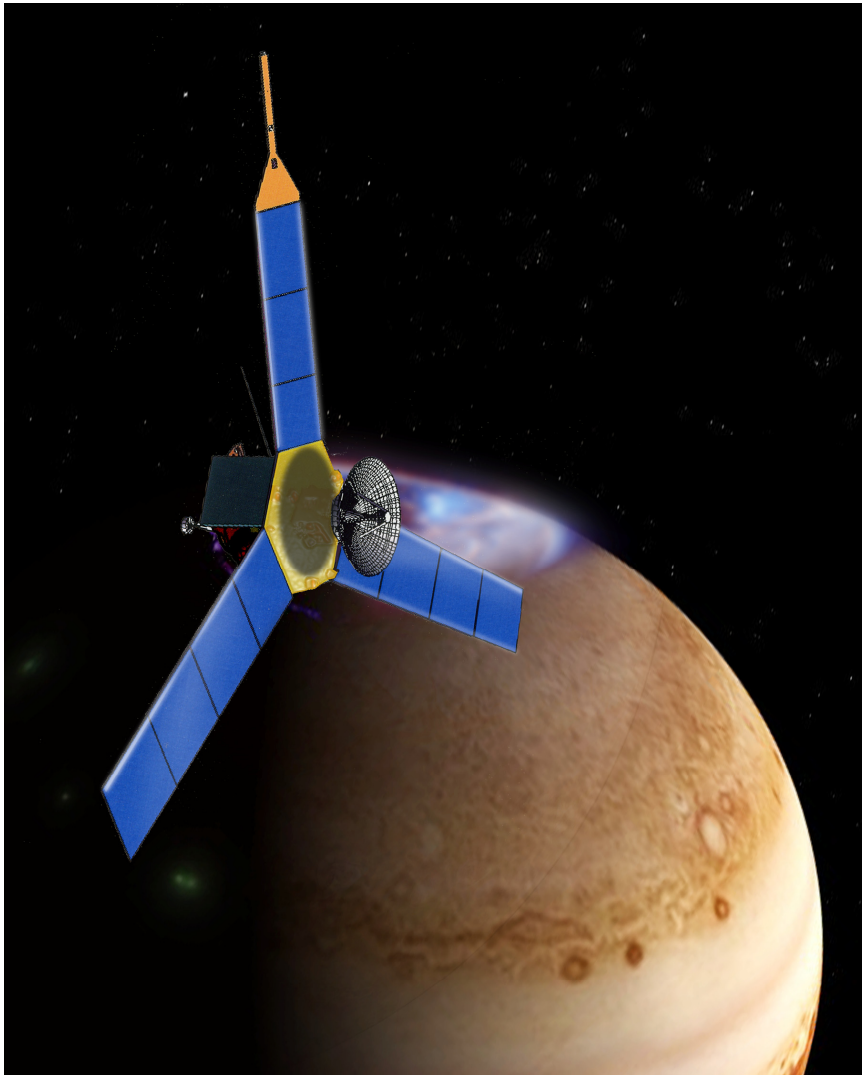
Characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras.



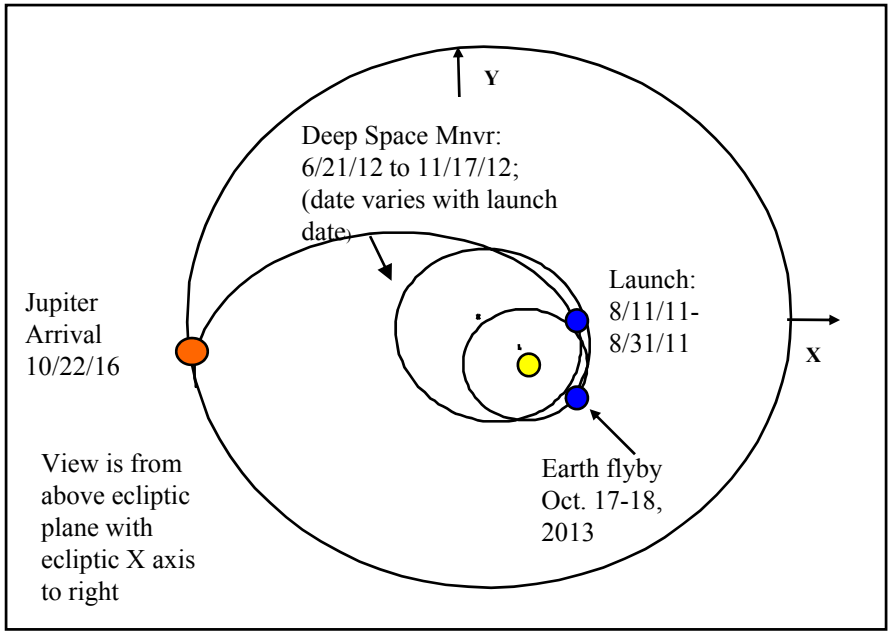




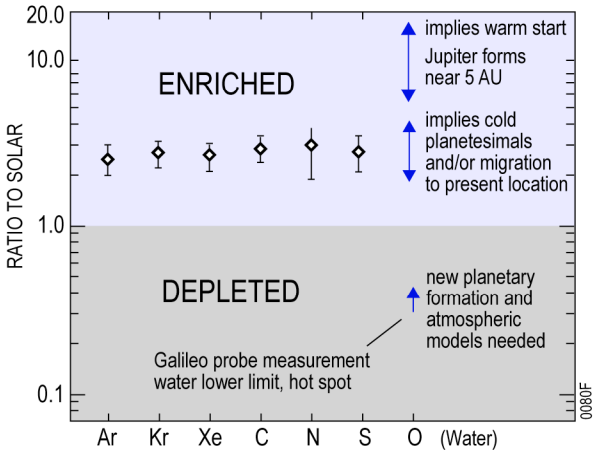
Overview



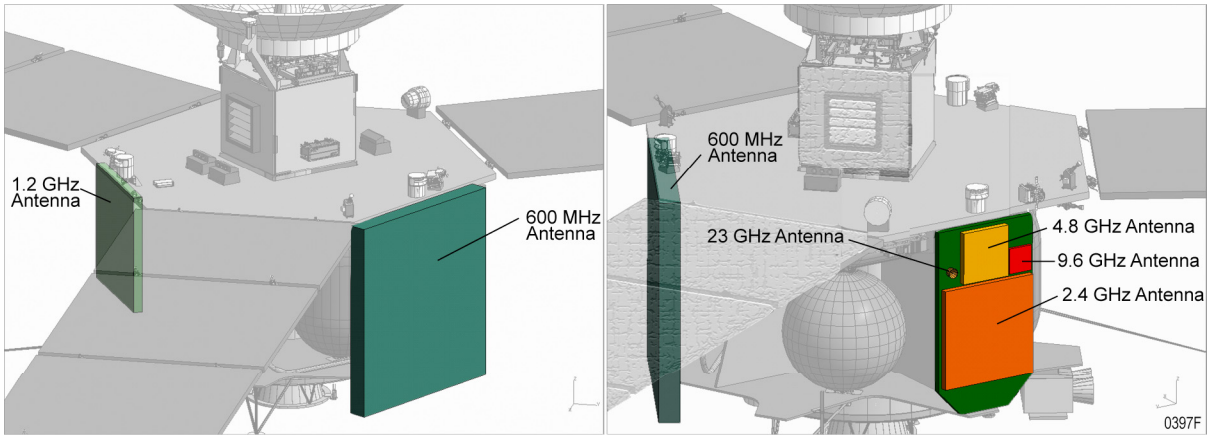
- Spinning, solar powered spacecraft
- Launch in August 2011
- Jupiter arrival in 2016
- Polar orbit with a close perijove
- 6,000 km to 8,000 km above the cloud tops
- 7 Scientific Instruments
- Visible camera



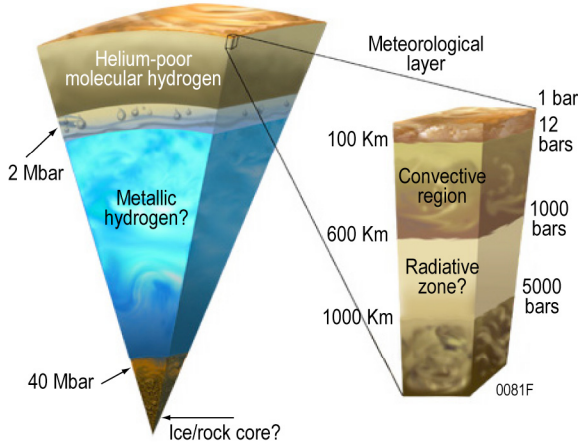
Origin

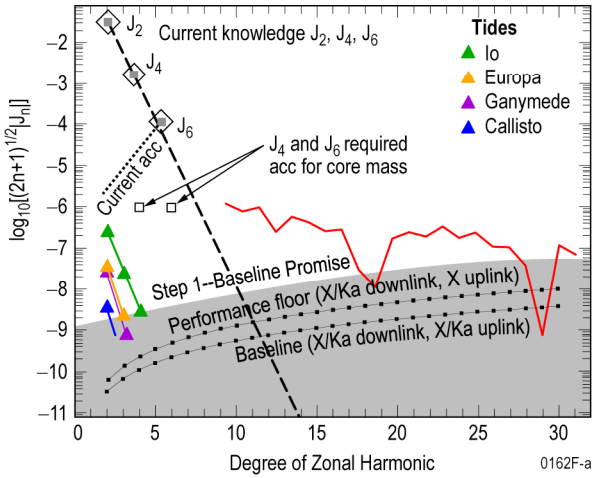


- Mass of Jupiter's core helps distinguish among competing scenarios regarding Jupiter's formation
  - Microwave Radiometer (MWR) to measure global abundances of oxygen and nitrogen
  - X and Ka band radio instruments to measure gravitational field
- 6 different antennas on MWR to sound from below the ammonia cloud tops to as deep as practical

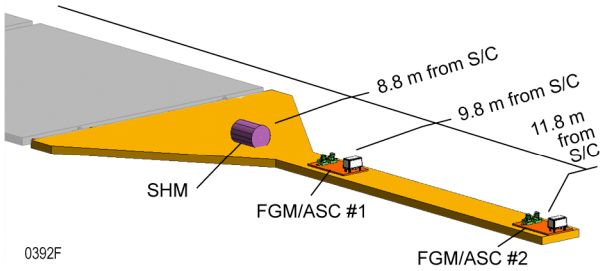


Interior



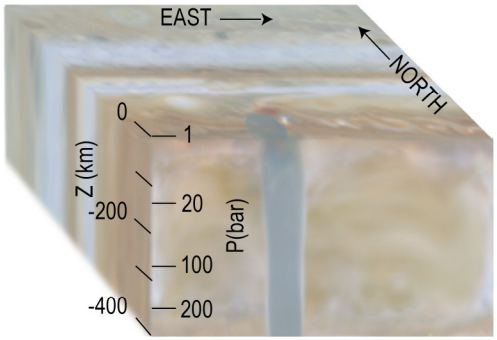


Diamonds represent current knowledge. Triangles show expected tidal responses. Lines show signatures of solid body (dashed) and differential (red) rotation.

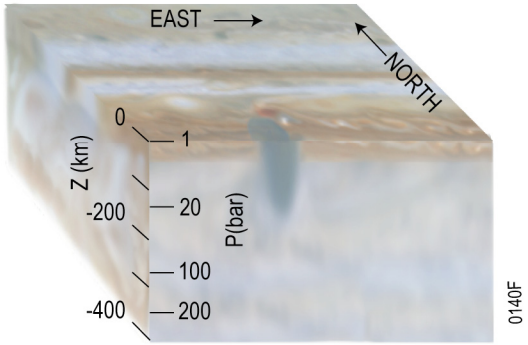


- Measure gravity field, magnetic field and water abundance to determine
  - Structure of the planet
  - Nature of deep convection
  - Process of magnetic field generation
- Gravity science experiment (X/Ka uplink and downlink)
- Magnetometer experiment
  - Mounted on boom at end of one of the solar array panels
  - Pair of fluxgate sensors (FGM) to measure vector mag field
  - Array of scalar helium mag (SHM) cells to measure magnitude of field

Atmosphere



Large scale flow
Dominates & belt-zone
Structure penetrates to
Depths > 200 bars.



Small scale convection
Dominates & the belt-zone
Structure disappears below
The water cloud base @ 6
bars

- Juno produces five pole-to-pole latitudinal maps of microwave opacity as a function of altitude
- Mapping of water and ammonia to depths greater than 100 bars indicates whether large scale circulation is deep or shallow
- Use the MWR Instrument for this investigation

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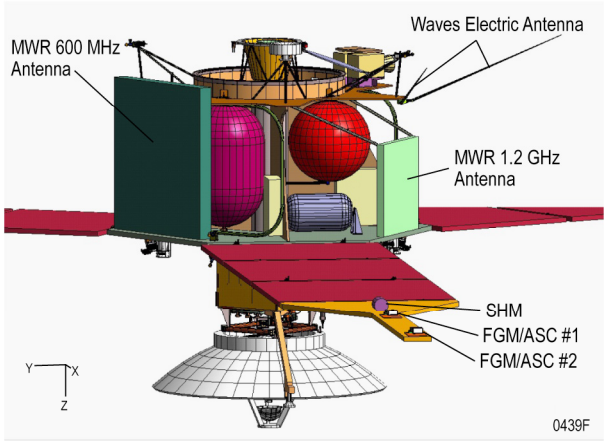
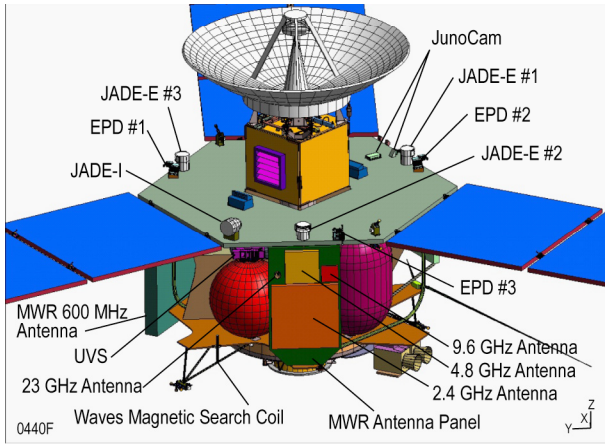
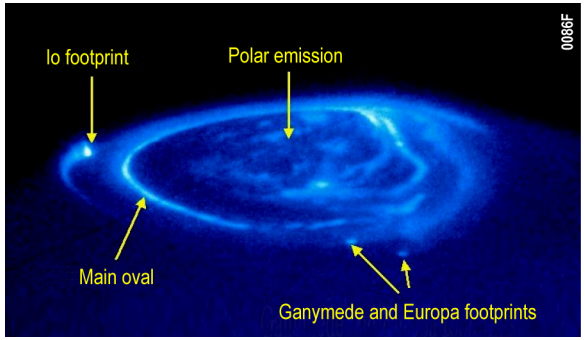
Polar Magnetosphere

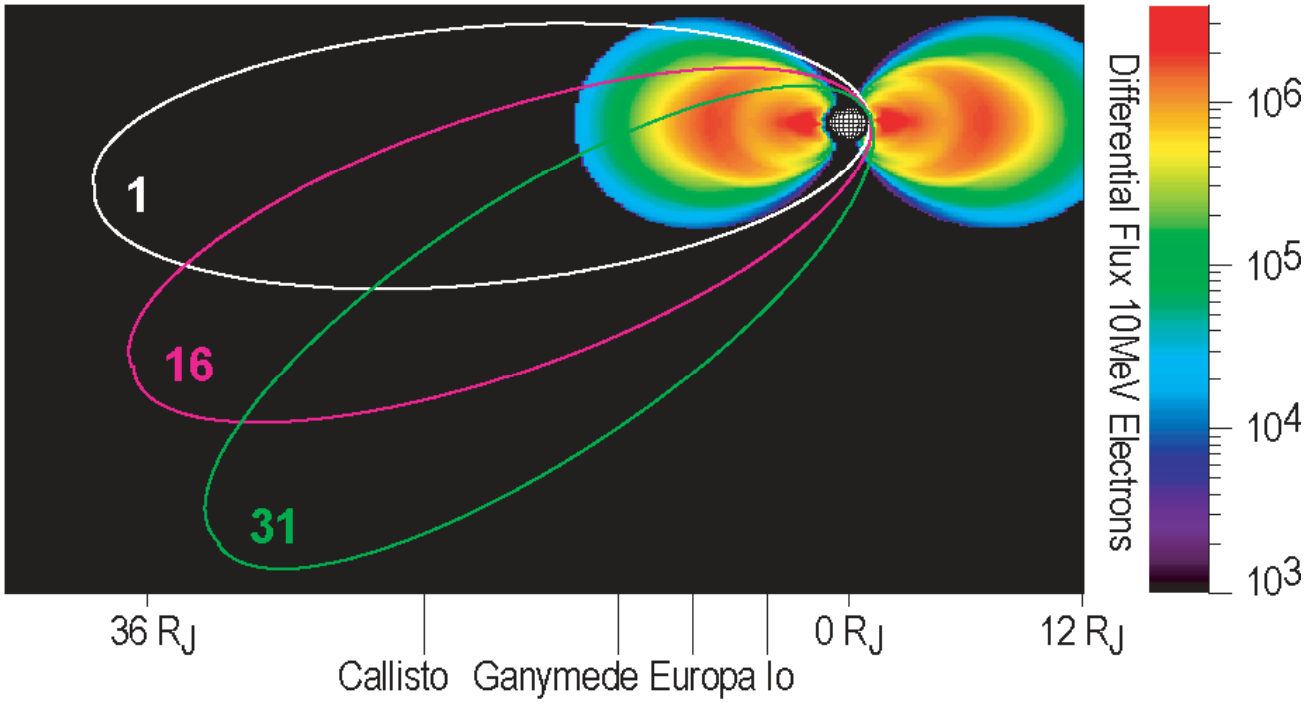






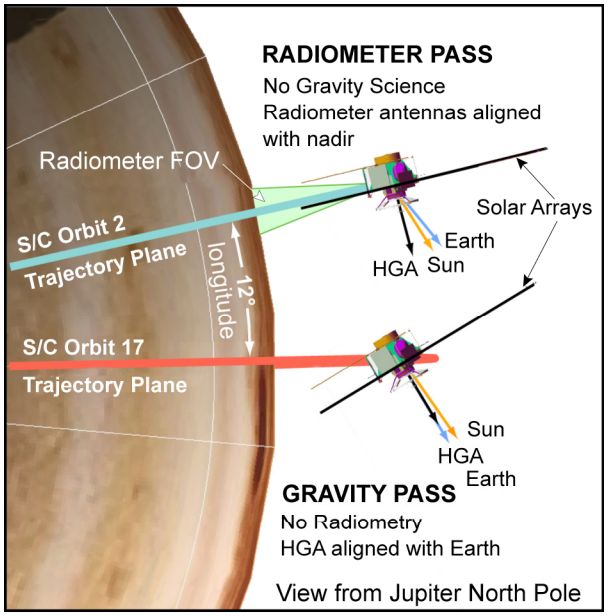
- Auroras driven by:
  - Rotation of the planet
  - Motion of its satellites across the magnetic field lines
  - Solar wind
- Suite of fields and particles instruments to investigate
- JADE Instrument - Plasma field
- EPD Instrument - Energetic particles
- Waves Instrument - Plasma waves
- UVS Instrument - UV auroral emissions

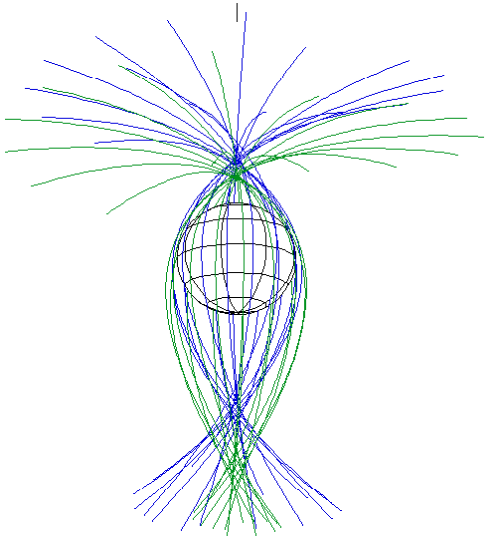
At Jupiter



- 11 day polar orbit
  - Perijove ≈ 1.06 RJ
  - Apojove ≈ 39 RJ
- 32, eleven day orbits ≈ 1 earth year
- Primary science acquisition at ± 3 hours around perijove
- De-orbit and enter Jupiter for disposal at end of mission

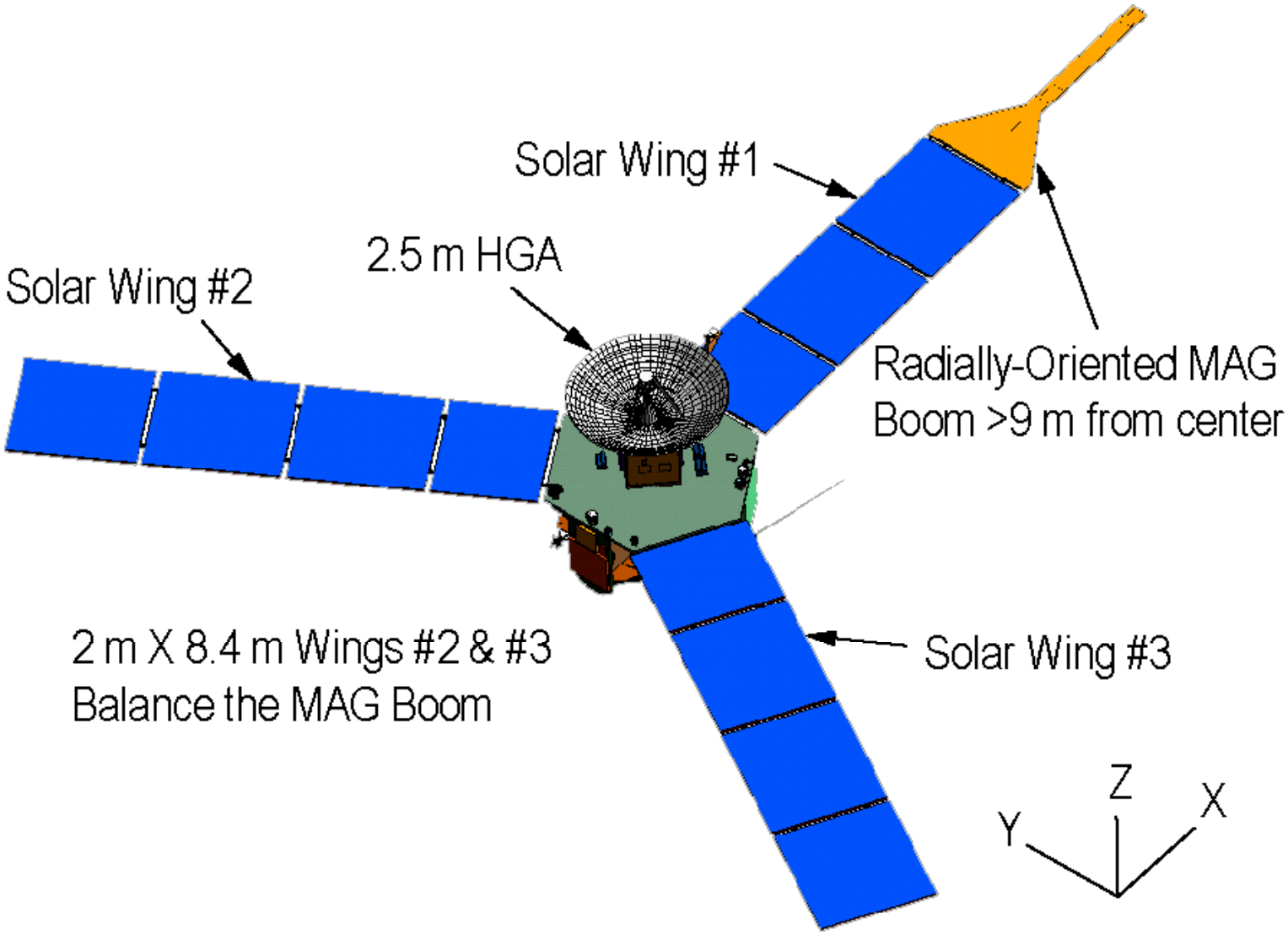
Science Orbits





- Only two basic science modes for science orbits:
  - Radiometer science mode ⇦ MWR is on, gravity science off, rest of instruments on
  - Gravity science mode ⇦ MWR is off, gravity science on, rest of instruments on
- Science orbits have equatorial crossings at equal longitudinal spacing
  - Orbits have a longitudinal spacing of 24 degrees for orbits 2 through 16
  - Orbit then adjusted 12 degrees for orbits 17 through 31
  - Results in overall longitudinal spacing of 12 degrees

Spacecraft Overview



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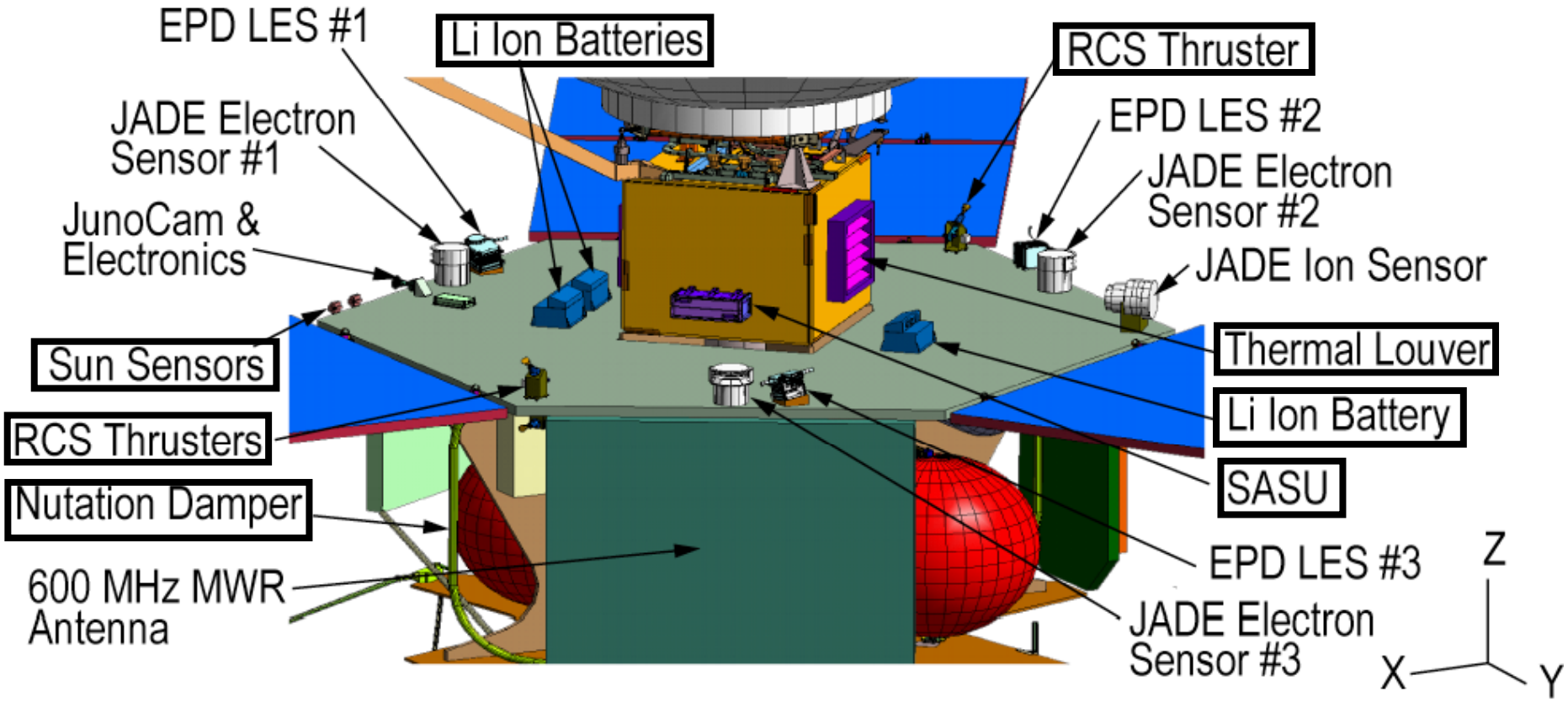
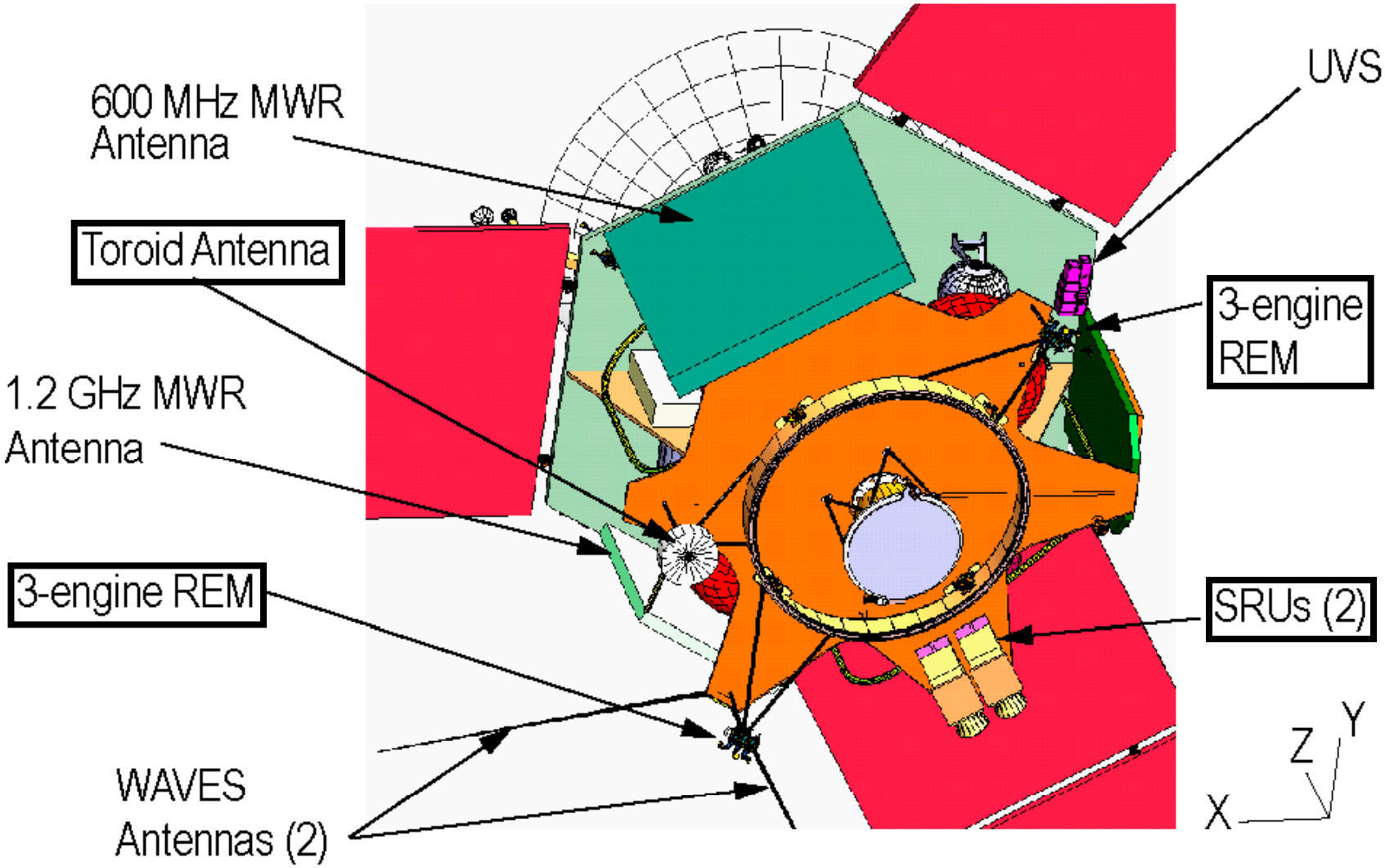
Spacecraft Detail (1)



Spacecraft Detail (2)



Conclusion

- Juno is designed to answer fundamental questions about the formation of Jupiter and our solar system
- Discoveries may also be applied to the formation of other gas giants and planetary systems
- Scientific, planning and managerial leadership is being provided by two highly experienced institutions: Jet Propulsion Laboratory and Southwest Research Institute
- Simplified mission approach:
  - Maximizes science return
  - Minimizes operational complexity
  - Avoids significant amount of the harsh Jupiter radiation environment
- Both the spacecraft and payload have significant heritage, reducing development risk