A Joint NASA/ESA Endeavour

Europa Jupiter System Mission

Science Theme:
The emergence of habitable worlds around gas giants

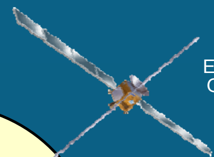
A Future Mission Concept

Goal: Determine Whether the Jupiter System Harbors Habitable Worlds

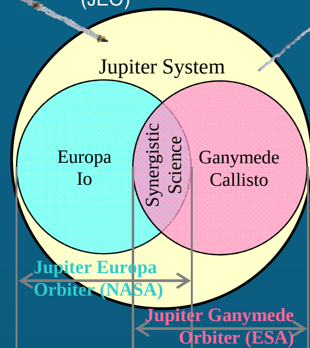
OBJECTIVES:

- Characterize and determine the extent of subsurface oceans and their relations to the deeper interior.
- Characterize the ice shells and any subsurface water, including the heterogeneity of the ice, and the nature of surface-ice-ocean exchange.
- Characterize the deep internal structure, differentiation history, and (for Ganymede) the intrinsic magnetic field.
- Compare the exospheres, plasma environments, and magnetospheric interactions.
- Determine global surface compositions and chemistry, especially as related to habitability.
- Understand the formation of surface features, including sites of recent or current activity, and identify and characterize candidate sites for future in situ exploration.

NASA Jupiter Europa Orbiter (JEO)



ESA Jupiter Ganymede Orbiter (JGO)



Goal: Characterize the Processes Within the Jupiter System

OBJECTIVES:

- Understand the Jovian satellite system, especially as context for Europa and Ganymede.
- Evaluate the structure and dynamics of the Jovian atmosphere.
- Characterize processes of the Jovian magnetodisk/magnetosphere.
- Determine the interactions occurring in the Jovian system.
- Constrain the origin of the Jupiter system.

Joint Jupiter Science Definition Team

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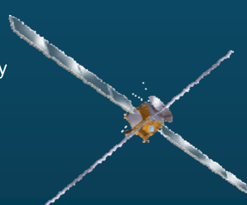
Two Flight Systems

- Independent launches allow flexibility in development cycles
- Highly capable instrumentation usable synergistically or independently
- Only JEO spends time in inner radiation belts
- Each flight system focuses on two of the four Galilean Satellites
- Enables full system coverage including Jupiter and its rings

Jupiter Europa Orbiter (JEO)

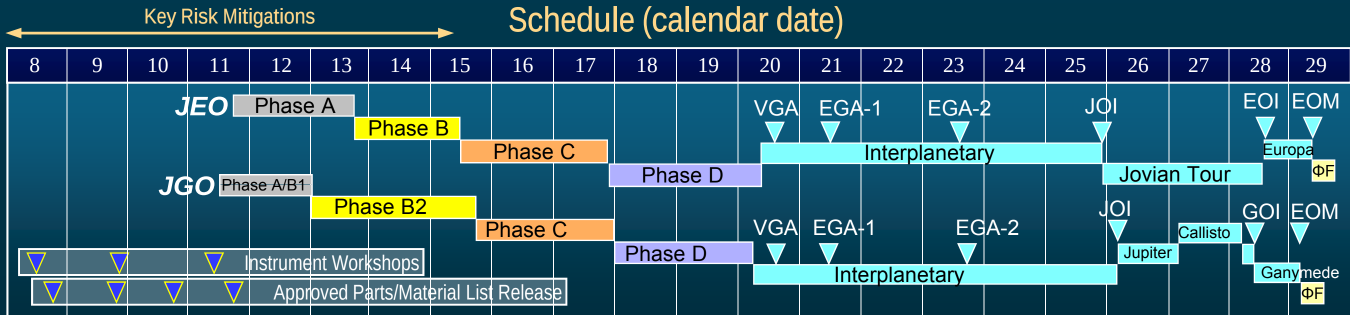


Jupiter Ganymede Orbiter (JGO)

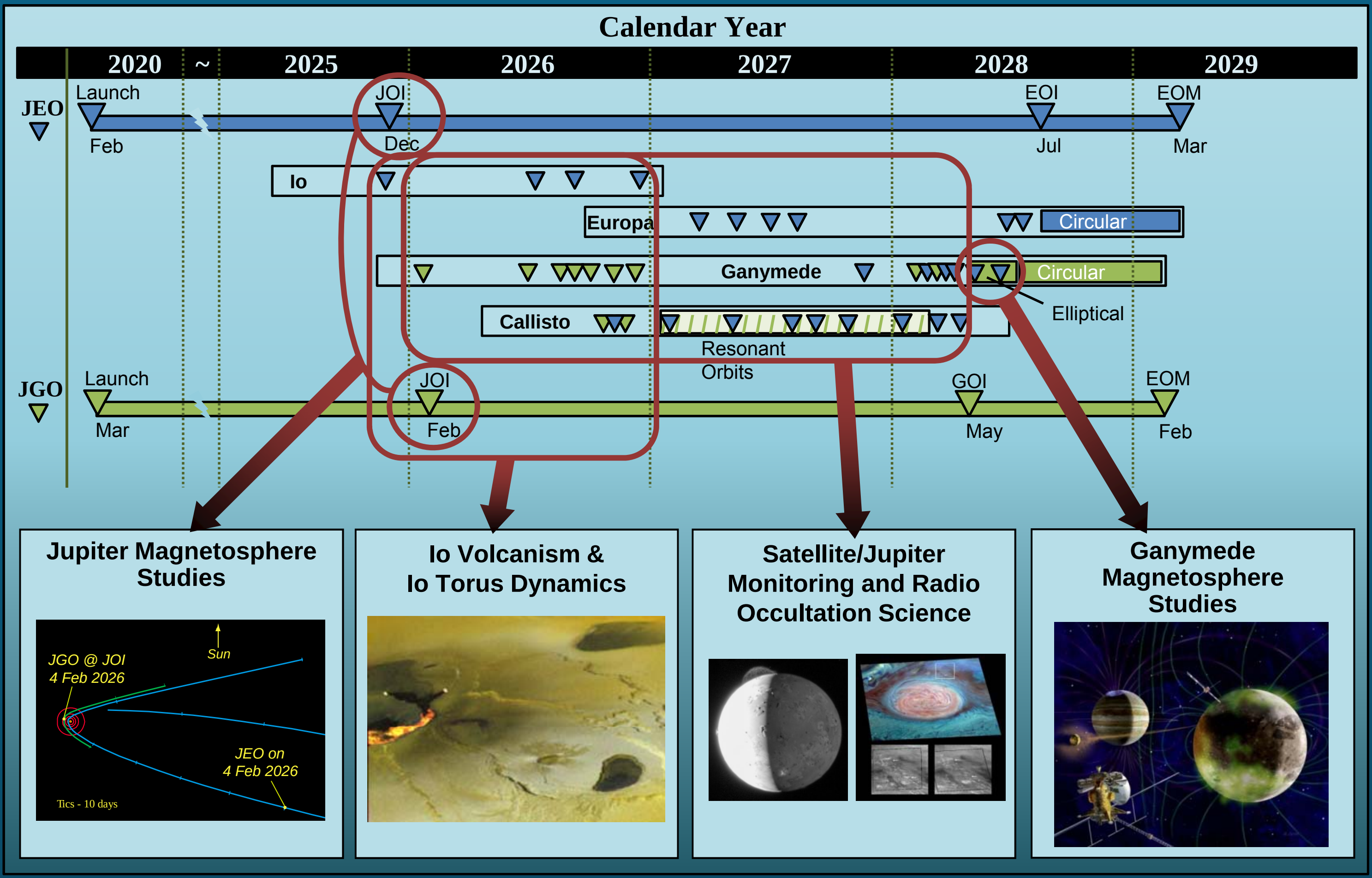
Model Payload

Instrument	*Jupiter Europa Orbiter*	*Jupiter Ganymede Orbiter*
Laser Altimeter	Single-beam @ 1064 nm, 50 m spot 1 m resolution @ 100 km	Single-beam @ 1064 nm, 10 m spot 1 m resolution @ 200 km
Radio Science	2-way Doppler and range Ka/Ka, X/X, X/Ka USO	2-way Doppler and range Ka/Ka, X/X, X/Ka USO
Ice Penetrating Radar	Dual frequency: ~5 & ~50 MHz Vertical depths: 3 & 30 km Dipole antenna: 30 m	Single frequency: 20-50 MHz Vertical depth: 5 km Dipole antenna: 10 m
Visible-IR Spectrometer	Pushbroom with along-track scan system, 2 channels, 400-5200 nm	Hyperspectral imager, 2 channels, 400-5200 nm, resolution 2.8 & 5 nm
UltraViolet Spectrometer	EUV + FUV: 70-200 nm, scan system for stellar occultations	EUV: 50-110 nm FUV + MUV: 110-320 nm
Ion and Neutral Mass Spectrometer	Reflectron Time-of-Flight 1-300 Daltons	Combined with the Plasma and Particles Package, M/ΔM > 1000
Thermal Instrument	Pushbroom imaging thermopile line arrays, 8-20 μm and 20-100 μm, 4 narrow filter bands	N/A
Narrow Angle Camera	Panchromatic pushbroom plus 9 color framing mode	High resolution, panchromatic pushbroom, 350 -1050 nm, IFOV 0.005 mrad
Wide and Medium Angle Camera	Wide-Angle: pushbroom, 3-color + panchromatic, IFOV 1 mrad Medium-Angle: pushbroom, panchromatic, IFOV 0.1 mrad	Wide-Angle: framing camera, 12 filters, 350 – 1050 nm, IFOV 2 mrad Medium-Angle: N/A
Magnetometer	Dual tri-axial fluxgate sensors on 10 m boom	Dual tri-axial fluxgate sensors on 3 m boom
Plasma and Particles	Plasma Analyzer: Electrons: 10 eV to 30 keV Ions: 10 eV to 30 keV Particle Analyzer: Electrons: 30 keV to 1 MeV Ions: 30 keV to 10s of MeV	Plasma Analyzer: Electrons: 1 eV to 20 keV Ions: 1 eV to 10 keV Particle Analyzer: Electrons: 15 keV to 1 MeV Ions: 3 keV to 5 MeV ENA: 10 eV -10 keV
Submillimeter Wave Instrument	N/A	2 channels, 557 & 1200 GHz, 100 kHz resolution
Mass	**106 kg**	**98 kg**

Schedule (calendar date)



Choreographed trajectories enable unique synergistic science throughout the mission



Mission Overview

- Two separate launches in 2020
- Both spacecraft would use Venus-Earth-Earth Gravity Assist (VEEGA) trajectory
- First spacecraft would be a pathfinder for second, improving satellite ephemerides
- Multi-year tours of Jovian system, including synergistic science from both flight systems with many flybys each of Io, Europa, Ganymede, and Callisto, continuous magnetospheric monitoring, regular monitoring of Io and Jupiter’s atmosphere and Jupiter’s ring system
- Spacecraft constantly and simultaneously monitor Jovian magnetosphere and/or the solar wind as they move in and out of the Jovian magnetosphere
- Mission design can tailor trajectories for specific geometries, including mutual satellite occultations for ionospheric and neutral atmospheric science, upstream/downstream magnetospheric measurements, stereoscopic satellite observations, especially of Io and its plumes, Jupiter atmosphere collaborative observations, especially of Jupiter's auroras, dual spacecraft exploration of Ganymede's magnetosphere, both individually and simultaneously
- Europa orbital phase
  - Initial, circular 200 km altitude orbit at 95º – 100° inclination
  - Transfer to 100 km orbit ~ one month after EOI
- Ganymede orbital phase
  - Initial, elliptical 200 km × 6000 km at 86° inclination
  - Final, circular 200 km orbit
- Flight systems would eventually impact Europa and Ganymede