Exploring the habitable water worlds of Jupiter — Callisto, Ganymede,and Europa

Jupiter Icy Moons Orbiter

Mission Characteristics Overview to the Forum on Concepts and Approaches for Jupiter Icy Moons Orbiter

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June 12 - 13, 2003

Agenda

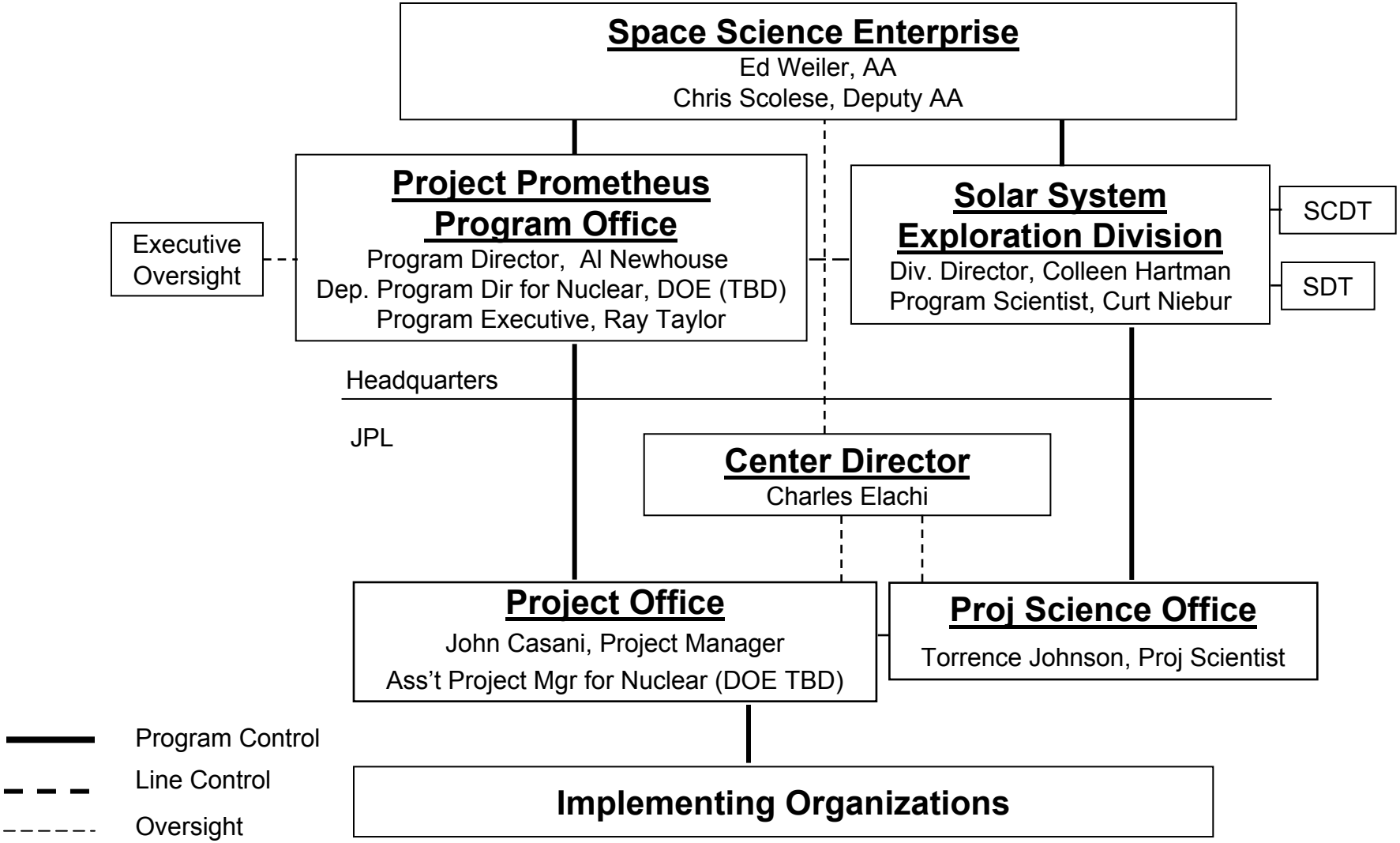
- **Project Overview**
  - Project Objectives
  - Project Organizational Approach and Organization
  - Schedules
- **Mission Overview**
  - Mission Objectives
  - Mission Design – Mission Timeline
  - Flight System Overview
  - Mission Characteristics
  - Mission Comparisons – JIMO to historical missions
  - Potential Enhancements – Jovian Atmospheric Probes, Europa Landers, Io followon mission

Project Objectives

- The Project will develop the mission to meet the following overarching objectives:
- Technology
  - Develop a nuclear reactor powered spacecraft and show that it can be processed safely, launched safely, and operated safely and reliably in deep space for long-duration deep space exploration
    - Subsidiary to this major objective is the development of nuclear fission technology and associated system technologies preparatory to demonstrating their effectiveness in deep space exploration
- Science
  - Explore the three icy moons of Jupiter – Callisto, Ganymede, and Europa and return science data that will meet the highest scientific goals as set forth in the Decadal Survey Report of the National Academy of Sciences.
    - The high power and high data rate afforded by nuclear power will enable science data return that is unprecedented in quality and quantity.

Project Prometheus

Jupiter Icy Moons Orbiter Organization

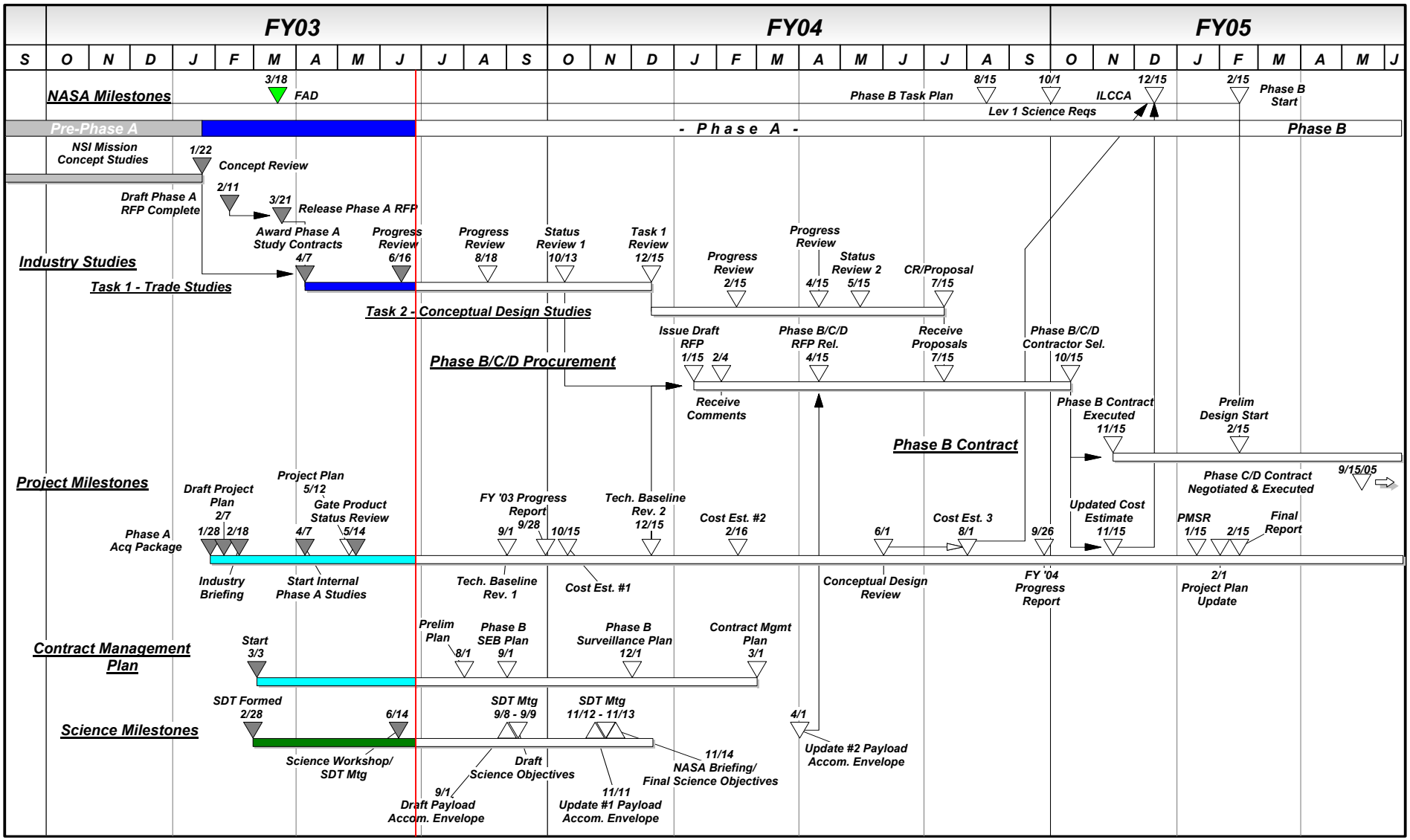


Acquisition Strategy

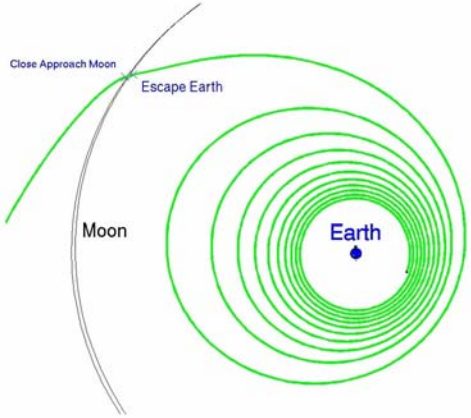
- **JIMO requires the best capabilities the Nation has to offer in order to meet the technology and science objectives**
  - NASA Centers, including JPL
  - DOE National Laboratories
  - Naval Reactors
  - Industry
  - Academia
  - Others
- **Major elements will be performed by Industry**
  - 3 study contracts (Boeing, Lockheed Martin, NGST) -- subject to “Rules of Engagement” to preserve a level playing field
  - Spacecraft Module and space system integration & test contract (with GFE elements)
  - Reactor Module contract
- **Mission Module will be provided by JPL**
- **Investigations will be competed via the NASA AO process**
- **All acquisition activities support the Independent Life Cycle Cost Analysis (ILCCA) and the target launch in 2011**

JIMO Phase A Schedule

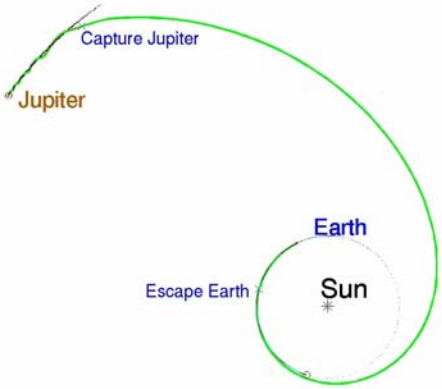
R-28 - Revised: 6/26/03



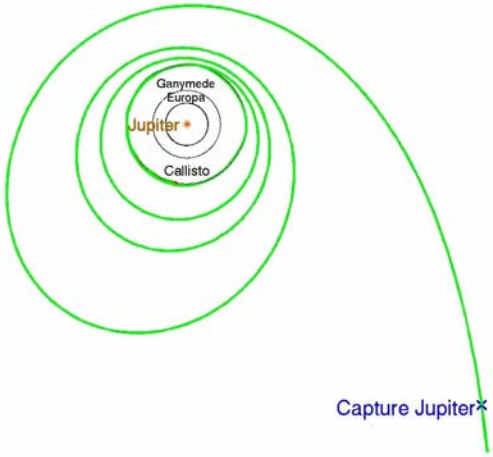
Trajectory Overview



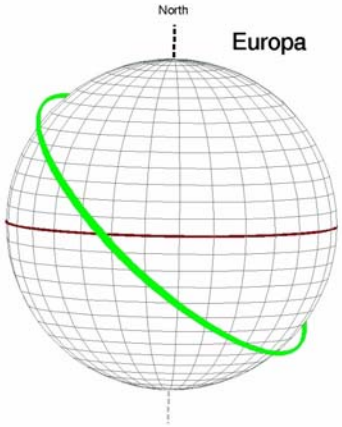
Earth Spiral Out with Lunar Gravity Assist



Interplanetary Transit

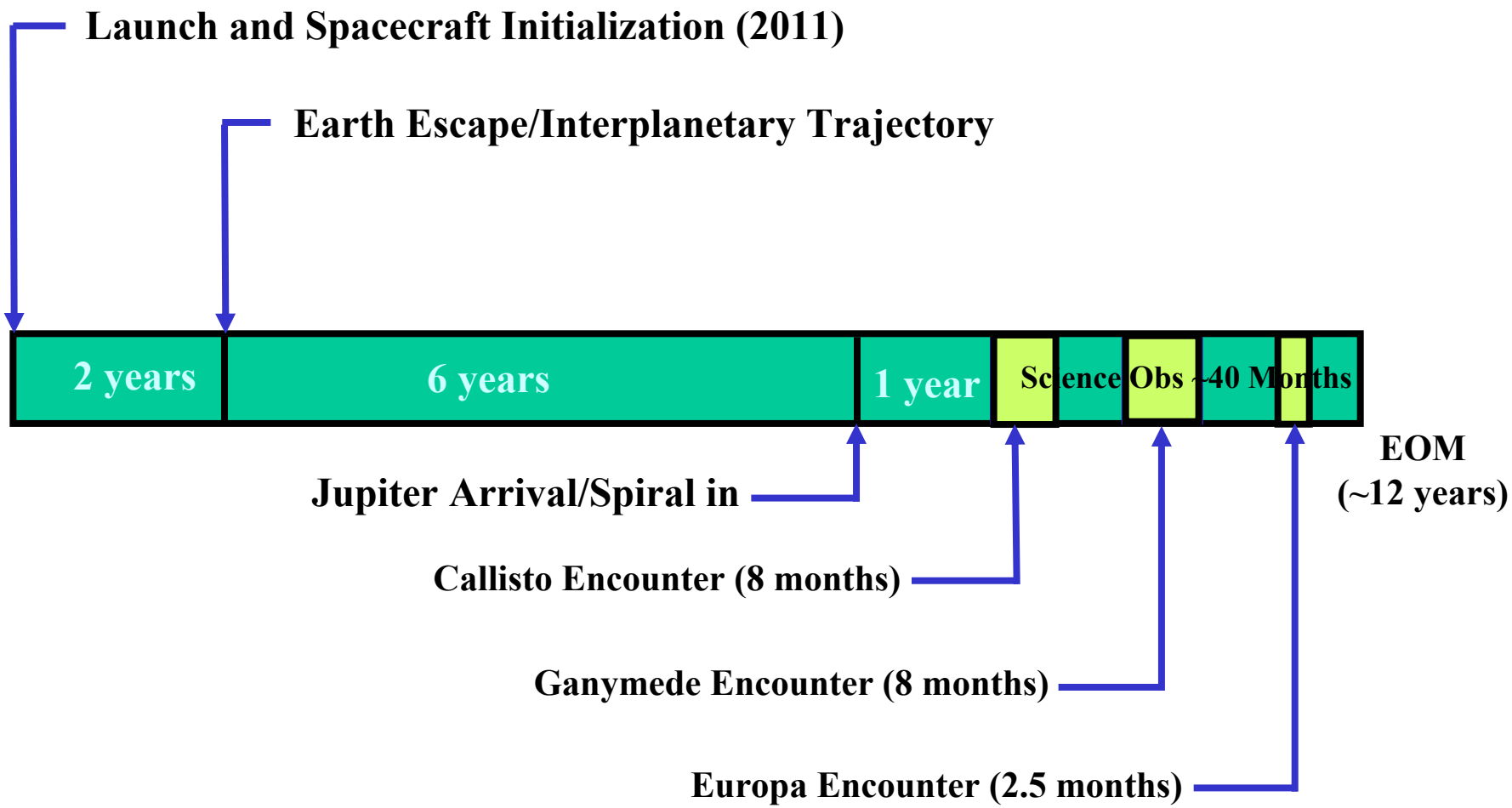


Jupiter Arrival and Spiral in

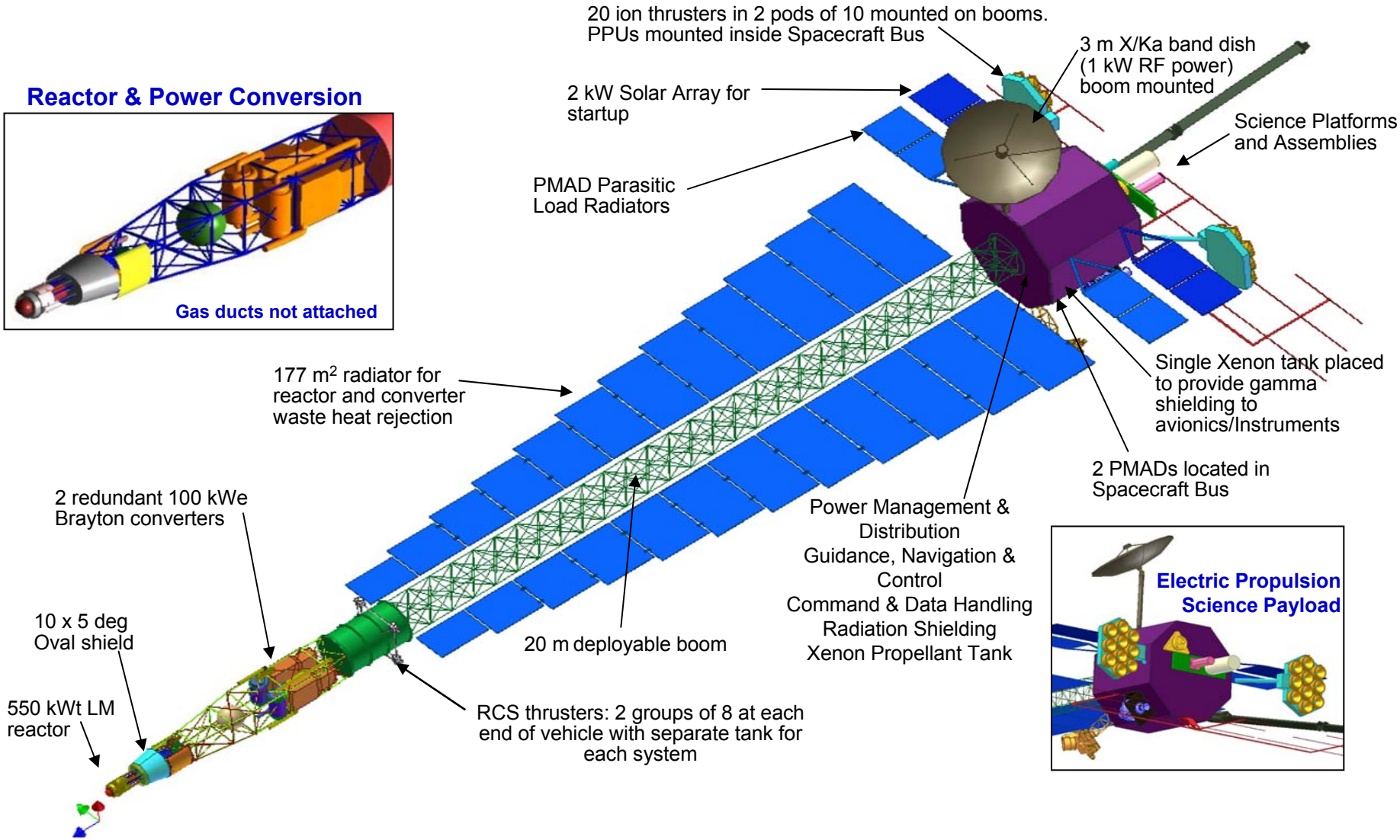


Europa Science Orbit

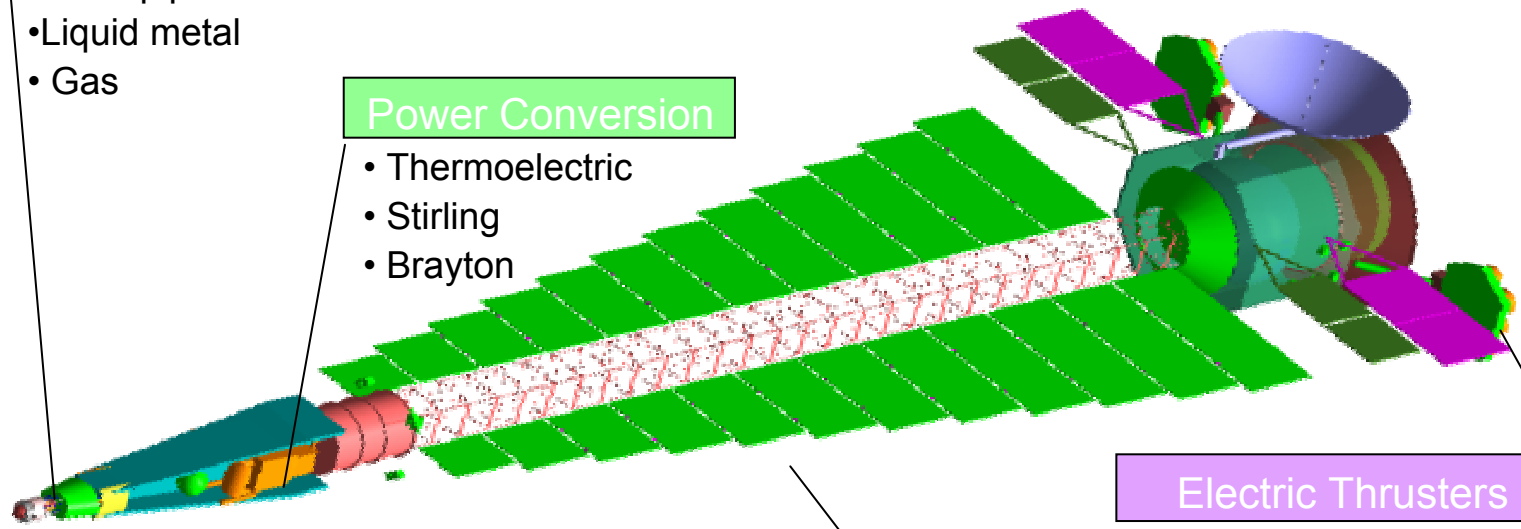
Mission Overview



Preliminary Government Study Configuration



Trade Options



Reactor Cooling
- Heat pipe
- Liquid metal
- Gas

Power Conversion
- Thermoelectric
- Stirling
- Brayton

Electric Thrusters
- Ion
- Hall
- ISP/ Thrust

Heat Rejection
- 2-Phase Loops
- Heat Pipes
- Pumped loops

- Trajectory options
- Cost/Performance options
- Radiation shield options
- Optical Comm. Experiment

Science Accommodation Capabilities

- **Mass:**

  600 kg science package including scan platform, instrument support functions (coolers, etc), potential auxiliary science packages, etc
- **Power:**

  >10 kW continuous power supplied to payload
- **Data Rates:**

  Planned 10 Mbps at Jupiter
- **Data Volume:**

  >50,000 Gbits over the mission lifetime
- **Observations:**

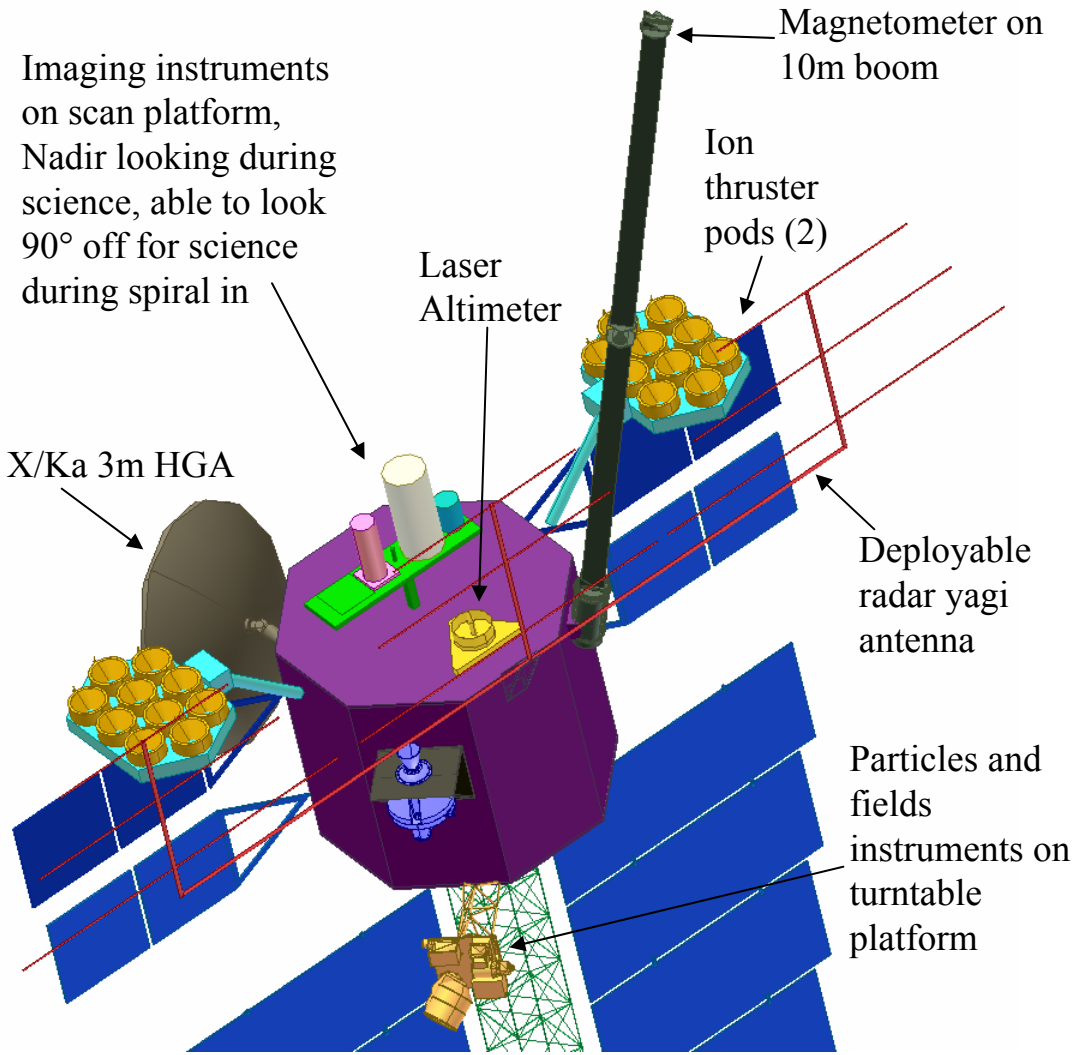
  Continuous in orbit (simultaneous data taking and comm)
- **Fields of View: (Preliminary)**

  2 pi stearadian for bus mounted instruments

  360 degree FOV for turntable instruments

  For scan platform ability to scan, track, target motion compensation

Notional Science Accommodation
(From JIMT Study)



Instrument Accommodation:

- Payload Data System with redundant computers and I/O
- Common 1394 high speed data interface
- NAC, MAC, WAC, IR Spectrometer and Thermal Imager on scan platform
- Laser altimeter, Radar antenna body mounted
  - Radar yagi folds back during spiral in for clear imaging FOV
- Ion Counter, Particle Detector, Mass Spectrometer, Dust Detector, and Plasma Spectrometer on Turntable allowing 360° scans
- Magnetometer on boom

JIMT SLO TID Summary
Dose in Kilorads (Si)

Spherical Shell Thickness	Jovian	Reactor	Earth Spiral	Total
10 mil Al	25000	25	12000	37000 krads
30 mil Al	12000	25	1700	14000 krads
50 mil Al	7400	25	720	8100 krads
100 mil Al	4100	25	140	4300 krads
300 mil Al	1200	25	14	1200 krads
500 mil Al	580	25	8	610 krads
1000 mil Al	200	25	5	230 krads
3000 mil Al	38	25	3	66 krads

JIMT SLO DDD Summary
Equivalent 1 MeV Neutrons/cm2

Spherical Shell Thickness	Jovian	Reactor	Earth Spiral	Total
10 mil Al	6.0E13	1.0E11	5.3E11	6.1E13
30 mil Al	1.7E13	1.0E11	3.3E11	1.7E13
50 mil Al	1.0E13	1.0E11	2.1E11	1.0E13
100 mil Al	5.7E12	1.0E11	1.5E11	6.0E12
300 mil Al	1.9E12	1.0E11	1.3E11	2.1E12
500 mil Al	9.7E11	1.0E11	8.5E10	1.2E12
1000 mil Al	3.4E11	1.0E11	5.2E10	4.9E11
3000 mil Al	3.2E10	1.0E11	3.0E10	1.6E11

JIMO Expected Environments
(EMC and Magnetics)

- **The JIMT power distribution system, ion thrusters, and solar arrays will generate large magnetic fields**
  - AC magnetic fields (10 m boom length):
    - 100 nT at 1.5kHz (spike at this freq)
    - 2-10 nT outside this band
  - DC magnetic fields (10 m boom length): 10 nT
    - Assuming Cassini magnetic cleanliness program
- **The Ka band communications system and potential ice penetrating radar will produce large radiated E-fields**
  - Ka band radiated E-field: 150 V/m (2m from antenna, ~13 GHz)
  - Ice penetrating radar radiated E-field: 350 V/m (1 m from antenna 15 to 50 MHz)
- **UHF**
  - UHF radiated E-field: 100 V/m (1m from antenna, 400 MHz)