EPSC Abstracts,
Vol. 4, EPSC2009-306, 2009
European Planetary Science Congress,

The Planning Payload for the EJSM Jupiter Europa Orbiter

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Introduction

The Jupiter Europa Orbiter (JEO) is one component of the proposed multi-spacecraft Europa Jupiter System Mission (EJSM) designed to obtain data in support of the science theme of studying the emergence of habitable worlds around gas giants.

The JEO planning payload, while notional, is used to quantify engineering aspects of the mission and spacecraft design along with operational scenarios to obtain the data needed to meet the science objectives. The instruments were defined to (1) understand the viability of an approach to meet the measurement objectives, (2) evaluate performance in the Jovian radiation environment and (3) assess the ability to meet planetary protection requirements. The actual instrument suite would ultimately be the result of an Announcement of Opportunity (AO) selection process carried out by NASA.

Payload Configuration

The sensor portions of the instruments in the JEO planning payload are located on the nadir facing deck of the spacecraft (Fig. 1). A shared electronics chassis houses the electronics portion of the instruments making optimal use of radiation shielding mass. A spacecraft supplied 10-meter boom is deployed for use by the magnetometer.

All instruments are body-mounted, co-aligned and nadir pointing for simplification of spacecraft operations. Instrument articulation required for target motion compensation, limb viewing or other purposes would be implemented within the instrument.

Payload Compliment

The JEO planning payload consists of a set of remote sensing instruments, fields-and-plasma instruments, and both X-band and Ka-band telecommunications systems that provide Doppler and range data and for accurate orbit reconstruction.

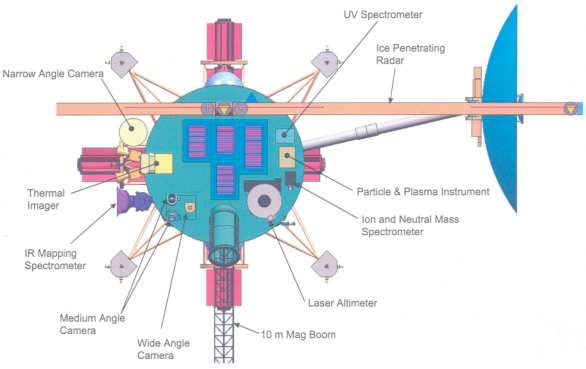

Fig. 1 The sensors of the Jupiter Europa Orbiter instruments are located on the nadir facing spacecraft deck, except for the Magnetometer sensors that are located on a 10-meter boom.

Ice Penetrating Radar

The notional Ice Penetrating Radar (IPR) is a dual-frequency sounder operating at 50 MHz with 10 MHz bandwidth and at 5 MHz with 1 MHz bandwidth. The higher frequency band is designed to provide high spatial resolution for studying the subsurface above 3 km with high vertical resolution (~10-m). The lower frequency band is designed to search for the ice/ocean interface or the possible transition from brittle to ductile ice in the deep subsurface at a depth of up to 30 km with modest vertical resolution (~100-m). A dipole antenna array is employed in either mode. Significant data processing within the instrument, including range compression, presuming, Doppler filtering, data averaging and resampling, are required to reduce the output data volume in a global survey mode.

Camera Package

The Camera Package consists of a Wide Angle Camera (WAC), a Medium Angle Camera (MAC) and a Narrow Angle Camera (NAC). The notional

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WAC obtains global imagery (3-colors plus panchromatic) with 100-m resolution from a 100 km orbit. From a 200 km orbit, mapping swaths will overlap by 50% side-to-side providing stereo coverage at 200-m resolution. The notional MAC obtains panchromatic imagery of selected targets with 10-m resolution from a 100 km orbit. Stereo imagery from the MAC, obtained through the use of a dual optical system, is a desired JEO payload augmentation. The notional NAC obtains high-resolution (~1-m from a 100 km orbit) imagery of high priority targets. The addition of NAC color capability for enhanced Jupiter system science is a desired JEO payload augmentation.

Near-Infrared Spectrometer

The notional near IR Spectrometer (IRS) provides surface composition measurements, covering a wavelength range from 0.4- to >5.0-µm with spectral resolution of 6-nm below 2.5-µm and 12-nm above 2.5-µm. A targeted mode uses the full resolution of the instrument and employs motion compensation via a scan mirror or gimbal system, allowing sufficient integration time to achieve 25-m spatial resolution with an acceptable signal-to-noise ratio. A global mapping mode employs data compression and editing within the instrument.

Laser Altimeter

The notional Laser Altimeter (LA) provides ranging measurements in support of detection of a tidal bulge at Europa. The LA consists of a 1.064-µm laser transmitter, receiver optics and time-of-flight processing electronics providing range precision of better than 1-m. A 50-m laser spot size with a 26 Hz pulse repetition rate provides contiguous coverage along-track from a 100 km orbit.

Magnetometer

The notional Magnetometer is a dual fluxgate magnetometer with 3-axis sensors located at the tip and the halfway point of a 10-m boom. A sensitivity of 0.1 nT supports detection of the magnetic induction signal from an ocean within Europa. A maximum sampling rate of 32 Hz is required for measurement of ion cyclotron waves near Europa. A maximum field range of 3000 nT supports measurements near Io.

Plasma and Particle Instrument

The notional Plasma and Particle Instrument (PPI) consists of an array of sensor heads interfaced to a common set of processing electronics. Wide-angle coverage of ions and electrons is desired for viewing of plasma flow around Europa. A wide range of energies (a few eV to a > 10 MeV) is desired to fully characterize the environment at Europa.

Ultraviolet Spectrometer

The notional Ultraviolet Spectrometer (UVS) operates in the far ultraviolet (FUV) range of 110 – 190-nm with 0.5-nm spectral resolution and 100-m spatial resolution from a 100 km orbit. A scan system allows limb viewing and stellar occultation measurements by the nominally nadir viewing instrument.

Thermal Instrument

The notional Thermal Instrument (TI) is a simple design employing 2 or more broad infrared channels with pyroelectric or microbolometer detectors to obtain temperature measurements. A more sophisticated imaging Thermal Instrument employing a microbolometer array is a desired JEO payload augmentation.

Ion and Neutral Mass Spectrometer

The notional Ion and Neutral Mass Spectrometer (INMS) samples Europa's atmosphere and ionosphere covering a mass range of 1- to 300-Daltons with mass resolution greater than 500 and a pressure range of 10^{-6} to 10^{-17} mbar for neutrals and low-energy ions. Close fly-bys during the JEO orbital tour will enable additional INMS composition measurements.

Radio Science-Gravity

A dual-frequency X- and Ka-band transponder in the spacecraft telecommunication system provides 2-way coherent Doppler tracking and range measurements required for orbit reconstruction in support of gravity measurements. Radio occultations will be used to measure the ionosphere of Europa and other Jovian moons during JEO flybys. An Ultra-Stable Oscillator provides the capability for improved radio science during ingress and egress.