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Europa Lander: Mission Concept and Science Goals

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Abstract

Starting from 2007 Russian Academy of Sciences and Roscosmos considers the possibility to include Europa surface element in the EJSM/Laplace international mission to Jupiter system [1, 2]. The main scientific objectives of the Europa lander will be to search for signatures of possible present and extinct life, *in situ* studies of Europa internal structure, surface and environment. Clearly, remote investigations from the orbit around Europa would not be sufficient to fully address astrobiology, geodesy, and geology goals. A dedicated international Europa Lander workshop has been held in Moscow in February 2009. It summarized our knowledge and current status of this project in the following aspects: scientific tasks of the mission; current knowledge of Europa environment (interior, surface and atmosphere); astrobiology vision of Europa; synergy between the Europa Lander and EJSM/Laplace mission elements (including possible joint experiments); orbital constraints, radio relay options; scientific payload for Europa lander and expected difficulties; priorities for selection of the landing site; the Lander technical design including radiation protection.

The proposed space mission to Europa will include following basic stages:

- Interplanetary flight to Jupiter;
- Flight in the Jupiter-dominated zone ;
- Insertion into an orbit around Europa and landing.

Two variants of the interplanetary cruise are possible. First, a conventional scheme, including chemical propulsion and a series of gravitational maneuvers around Venus and the Earth has been considered. Alternatively, electric propulsion can be applied during the heliocentric cruise coupled with a single gravitational maneuver near the Earth. In either case, a heavy-class launch vehicle "Proton" with upper stage booster "Breeze-M" is necessary to carry out the spacecraft (SC) to the escape trajectory.

In the vicinity of Jupiter a series of gravitational maneuvers near Galileo satellites will be conducted in order to minimize propellant mass during the insertion into the orbit around Europa.

Any space mission to Jupiter system faces a considerable problem of radiation hazard. Lengthy approach to the planet is unacceptable due to enormous cumulative radiation dose, destroying the electronics of the spacecraft. The trajectory in the vicinity of Jupiter is chosen in order to minimize the duration of the trajectory within Europa orbit, and to exclude whenever possible entering within Io orbit. Estimations of charged particle fluxes and radiation doses under various shielding in different parts of the trajectory were made using different empirical models at each stage of the computations [3].

Following these basic considerations, the sequence of gravitational maneuvers in the vicinity of Jupiter has been chosen to be completed within less than two years. In the end of this stage the SC will be inserted into a circular polar orbit round Europa.

From this orbit remote studies of the surface will be conducted. The landing site meeting certain topography conditions will be chosen, also using

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the results of observations from EJSM Laplace Europa orbiter (JEO) led by NASA.

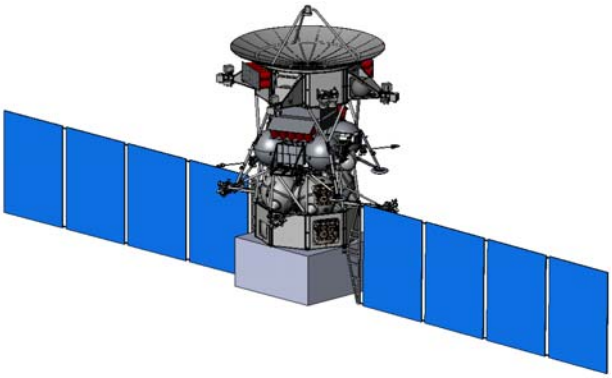
The landing module will be separated to perform an active soft landing onto the surface. The orbital module remains on the orbit and serves as a relay for the lander.

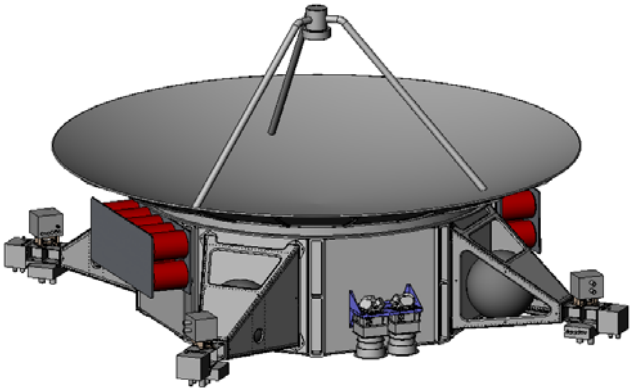
The following Europa Lander mission elements are presently considered:

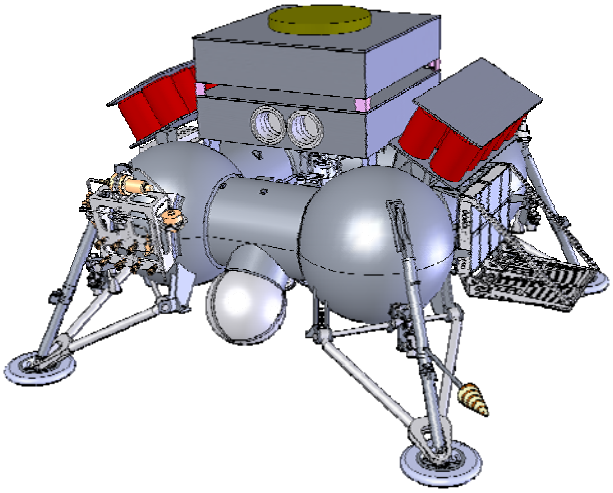
- The electric propulsion transport module;
- The orbital module;
- The landing module;
- Propulsion system.

Preliminary estimations show that the mass allocation for scientific equipment on the orbital module is about 50 kg, and on the landing device – about 60 kg. A strawman science payload set and its implementation is under discussion.

Phase 0 of the Europa Lander project has been started in 2009. The Russian national Europa Lander mission is included in the project of prospective Federal Space Programme 2011-2020 to be approved by the Government in April 2010.







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