



POLITECNICO

MILANO 1863

Reverse Engineering of Juno Mission

Homework 2

Course of Space System Engineering & Operations
Academic Year 2023-2024

Group 5

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Notation

ME	Main engine	PRM	Period reduction maneuver
RCS	Reaction Control System	JOI	Jupiter orbit insertion
DSM	Deep space maneuver	REM	Rocket engine module
TCM	Trajectory correction maneuver	I_s	Specific impulse
SK	Station keeping		

1 Mission analysis and ΔV budget

Ciao^[1]

2 Propulsion system architecture

The spacecraft axes are defined as shown in Figure 1: the +Z axis is aligned with the HGA, the +X is aligned with the MAG boom while the +Y axis is in the direction of cross product between +Z and +X.

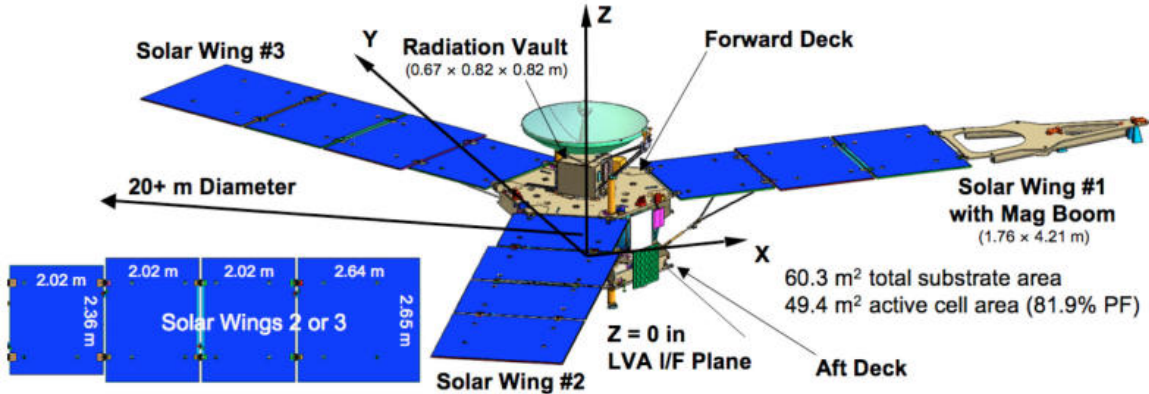


Figure 1: Axis description

2.1 ME and RCS

Juno is equipped with a dual mode propulsion subsystem: the bi-propellant ME uses the hypergolic couple Hydrazine and Nitrogen tetroxide ($N_2H_4 - N_2O_4$). This engine is utilized during the DSMs, JOI and PRM. The RCS uses only Hydrazine as mono-propellant and it is used for TCMs, attitude control and SK.

The ME is a Leros-1b, was built by Nammo^[2], and produces about 662 N of thrust with I_s of 318.6 s. It is and mounted inside the body of the spacecraft along the -Z-axis, centred between the propellant tanks and under the electronic vault. This solution has probably been adopted due to space requirements inside the Atlas V fairing. The ME is also shielded by a hatch that opens when a maneuver is needed. The RCS is composed by four REMs, each of them mounted along the plus and minus Y axes, as shown in Figure 3 and housing three thrusters providing a thrust of 4.5 N with I_s of 220s. The REMs are installed on pylons, raised respectively by 74 cm on the top deck and about 26 cm on the lower deck. Moreover, always with the need of limiting the interaction of the exhaust gasses with the on board instruments, mainly mounted on the top deck, and solar panels, the axial thrusters are canted 10° away from the Z-axis while the lateral thrusters are canted 5° away from the X-axis and 12.5° toward the Z-axis

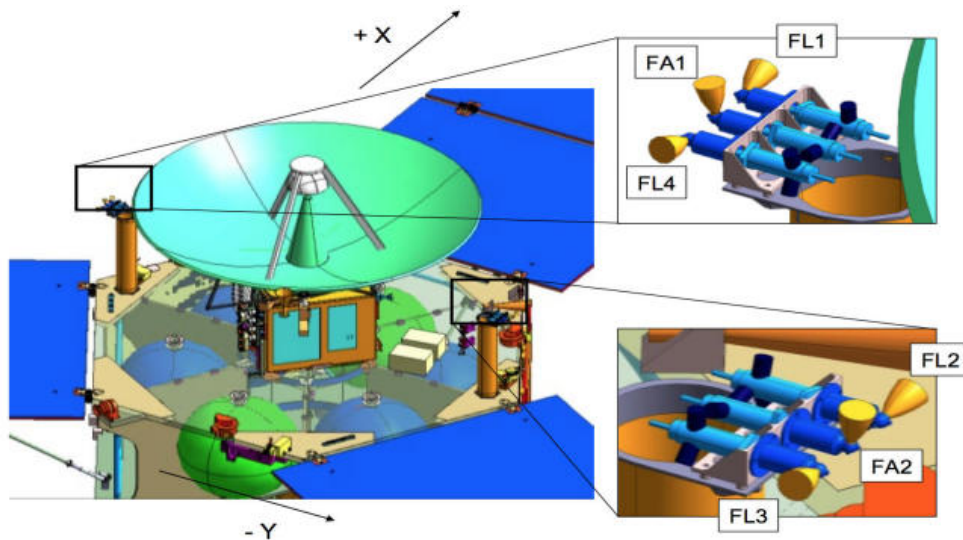


Figure 2: RCS forward mount

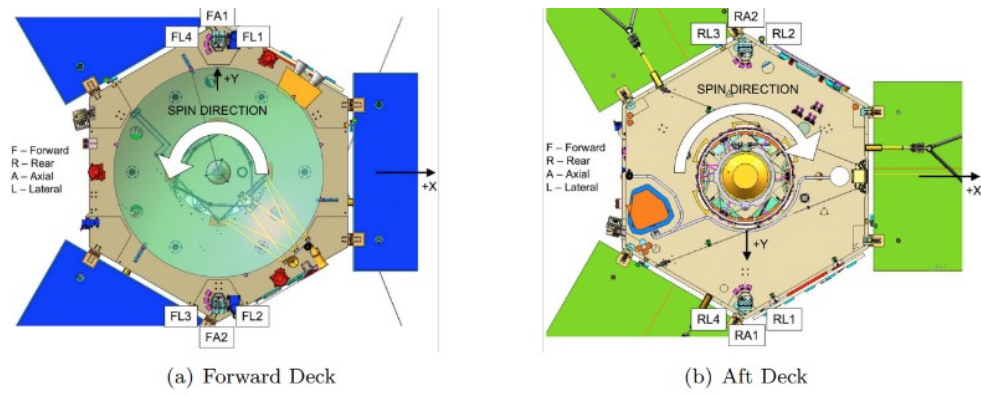


Figure 3: Forward and Aft deck view

3 Reverse engineering of propulsion system

Bibliography

- [1] Jet Propulsion Laboratory. *Juno Mission to Jupiter*. Site: <https://www.nasa.gov/>. 2022.
- [2] Nemmo. *Leros 1-b engine*. Journal of Geophysical Research: Planet. Site: <https://www.nammo.com/wp-content/uploads/2021/03/2021-Nammo-Westcott-Liquid-Engine-LEROS1B.pdf>.