

Mission Design Team: Dario Bautista, Wyatt Charrette, Clem Colwell, Joshua Toledo, Brennan Klatt, Kyle Loutzenhiser, Dustin Cruse, Joshua Laurain, Anthony Cortes
Advisors: Ahmad Bani Younes

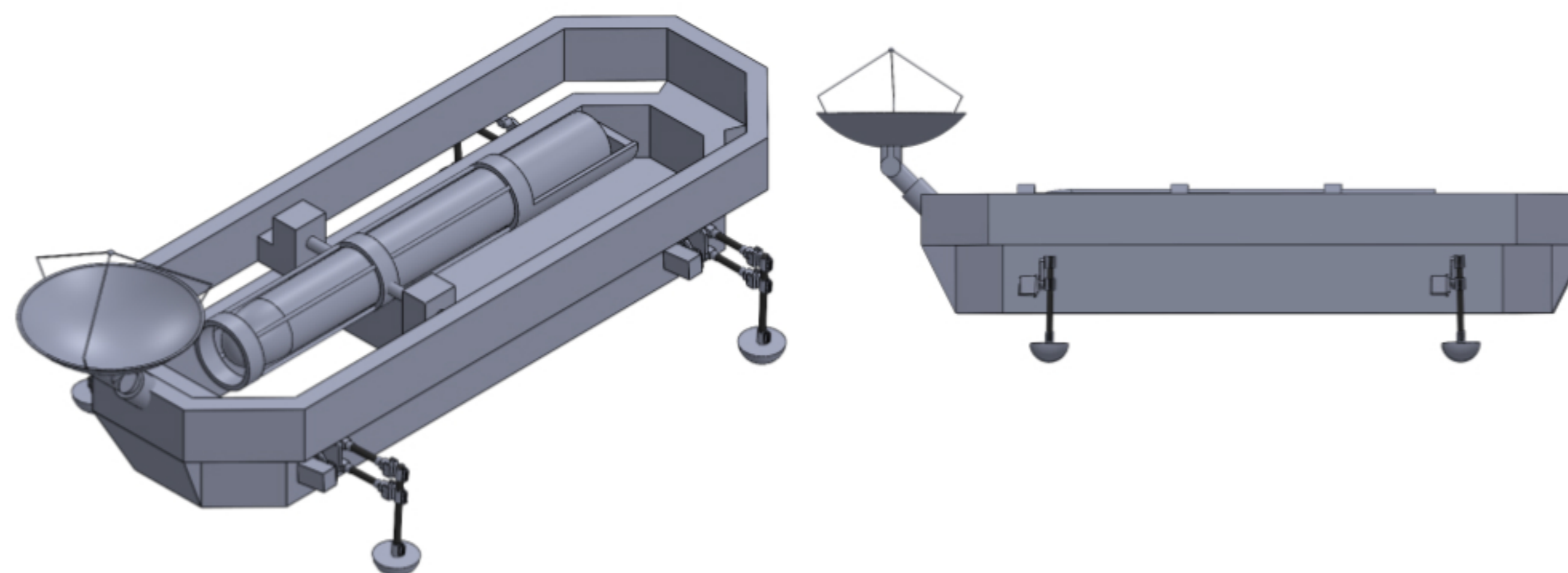
Site & Mission Background

Site: Europa
 A frozen moon orbiting Jupiter. Explorative missions (Galileo, JUICE, Juno, and Clipper) have discovered a liquid ocean beneath the frozen surface.

Goal
 Penetrate the surface and sample the ice and subsurface ocean environments

Mission Design Type
 Stationary Landing Vehicle, equipped with a deployable cryobot to investigate beneath the surface.

Lander Design



Mission Flight Plan

| Leg | Duration | ΔV /Speed Effect |
|-----------------|------------------|--------------------------|
| LEO - Mars | 2.018 yrs | 3.845 km/s |
| Mars Flyby | -- | 0.518 km/s |
| Earth Flyby | 0.655 yrs | 1.682 km/s |
| Earth - Jupiter | 4.145 yrs | -- |
| Total | 6.818 yrs | 6.045 km/s |

Objectives

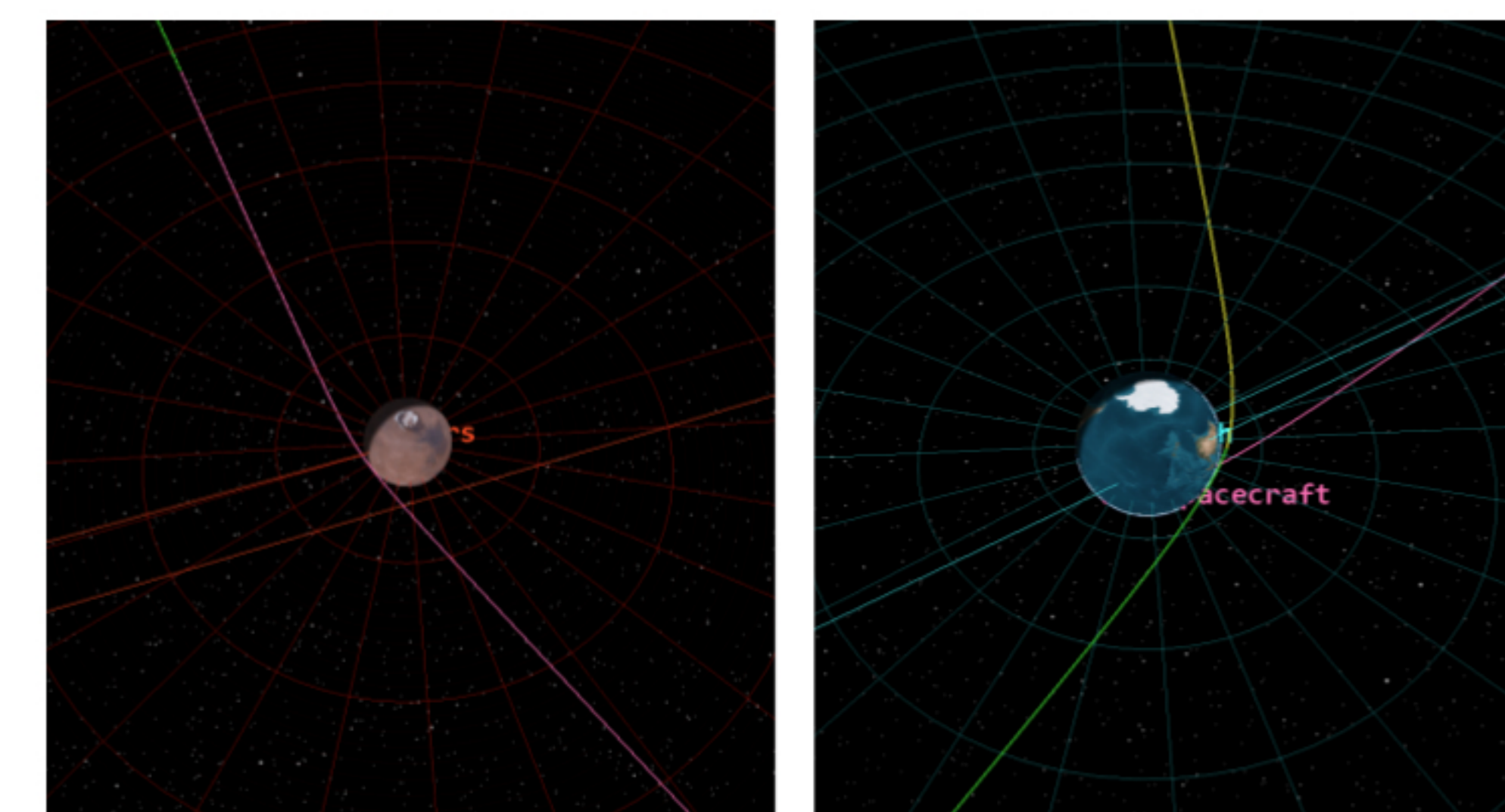
Search For Life
 Assessing surface and subsurface materials for inorganic composition using isotopic indicators.

Quantify Environmental Habitability
 Establishing radiation, thermal, and magnetic data reports of the environment..

Assess Glaciological Features
 Characterization and mapping of surface and subsurface features through imaging, radar/lidar, and mineral samples.

Subsystem Architecture

- Electrical Power**
 - > MMRTG: ~ 110 W continuous electrical power
 - > Li-Ion Battery: ~ 894 Wh of energy storage
 - > 28V Regulated power bus
- Thermal**
 - > **MMRTG**
 - o Required for Maintaining a stable temperature during mission timeline through thermal and electrical energy.
 - o Maximum of 2000W potential output by reactor in a deep space environment.
 - > **Passive Insulation**
 - o Paired with passive insulation to regulate and maintain the temperature provided by the MMRTG reduces electrical load of maintaining nominal temperature
 - > **Radiators**
 - o Conducting generated thermal energy to required areas and maintaining constant temperature on areas further away from the central reactor.
- Propulsion**
 - > Propulsion & Terminal Descent (Lander)
 - > Multistage descent driven by planetary protection (Class IV)
 - > Final phase focuses on lander-only controlled descent
 - > Hypergolic bipropellant (MMH / NTO)
 - o Self-igniting - high reliability
 - o Throttleable - precise landing control
- Onboard Data Handling**
 - > 2 GB mass memory (~5x margin)
 - o Supports buffering, missed passes, and data bursts
 - > CAN bus → low-rate, robust platform data
 - > SpaceWire → high-speed payload data transfer
 - > GR740-class rad-hard computer
 - o Integrated CAN + SpaceWire
- Communication**
 - > Antenna diameter: 3m
 - > Band: X-band at 8.4 GHz
 - > Hardware: 80 W Power Amplifier & 46 dBi HGA
 - > Performance: 256 kbps Downlink at 3 dB Margin
- Payload**
 - > **Prometheus Cryobot**
 - o Diameter: 4 m long 37 cm
 - o Nuclear Power thermal system generating 10kW
 - Passive thermal probe used to heat closed-loop hot water drilling
 - > **Cryobot Scientific Payload**
 - o Microfluidic analyzer
 - *Olympus DP28*
 - o Conductivity (CTD) probe
 - *Idronaut - Ocean Seven 28 (OSB)*
 - o Raman spectrometer and fluorometer
 - *In-situ Spectroscope (ISEE)*
- Structure**
 - > Legs
 - o Mechanical actuators to level the vehicle on rugged terrain
 - > Electronics Vault
 - o Rad shielded vault housing all non-rad protected electronics
 - > Antenna
 - o Posable actuators maintain direct-to-earth aim and communication
 - > Cryobot deployment
 - o Actuators allow for raising of the cryobot in preparation for deployment



Mars Flyby - 23 January 2037

Earth Flyby - 13 September 2037

System Requirements

Survivability Requirements
 External Temperature Range: -220 to 120°C
 Radiation Exposure: ≥300 krad (total ionizing dose)

Communication Requirements
 Max Communication Range: 5.2AU
 Operating Frequency: 8.4 GHz
 Minimum Data Rate: 256 kbps
 Pointing Accuracy: ±0.5°
 Minimum Elevation Mask: 10°
 Communication Window: 2.28 hr/day

Autonomy Requirements
 Minimum Autonomous Operability: ≥24 hrs

Key Risks & Mitigation

| Failure | Mission Impact | Mitigation Strategy |
|----------------------------|----------------------------------------------------|---------------------------------------------------|
| Radiation | Avionics failure leads to loss of control & data | Radiation vault, redundant OBC, and ECC |
| Thermal extremes | Payload of temperature range leads to loss of data | MMRTG heat, insulation, and active heaters |
| Communication delay | No real-time control leads to delayed response | Autonomous FDIR and onboard storage |
| EDL failure | Hard Landing leads to total mission loss | TRN, redundant sensors, shock-absorbing structure |
| Power failure | Loss of all systems | MMRTG, prioritizing power distribution |