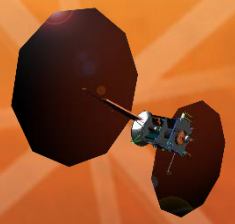


Oceanus NF4 Concept Overview

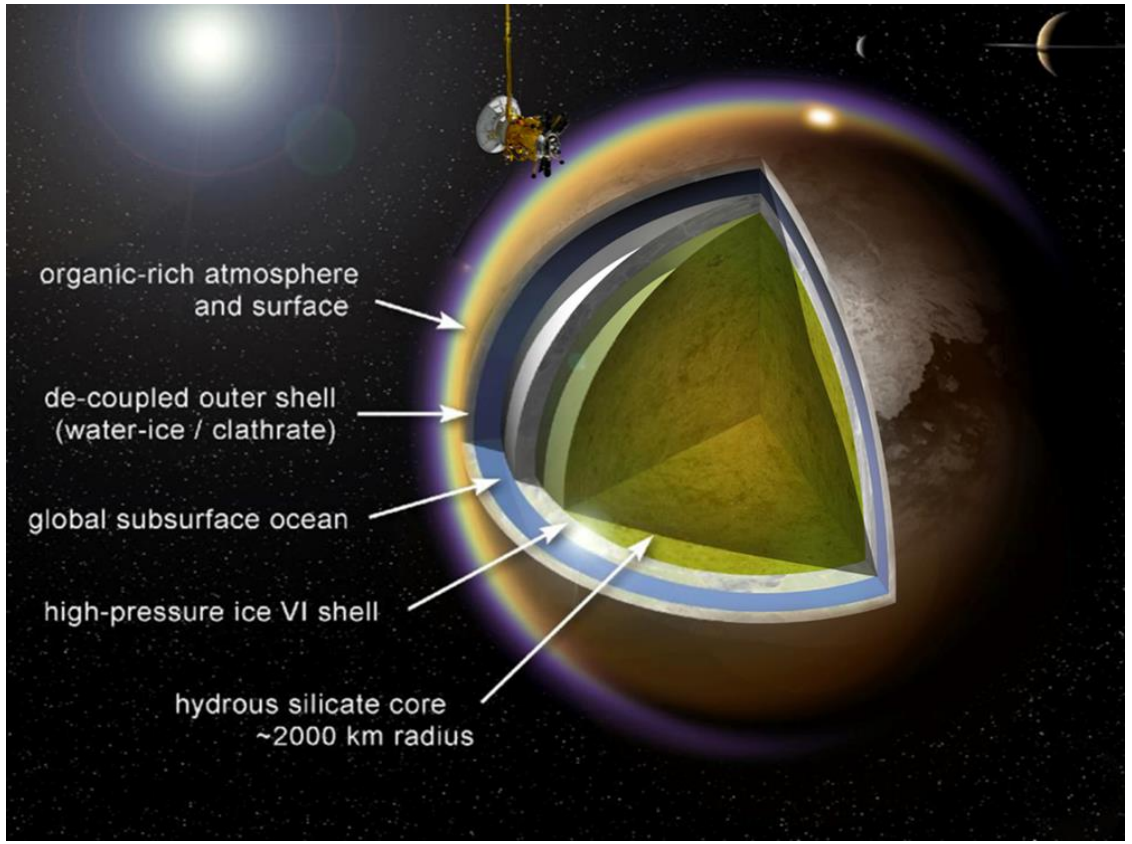
John Elliott, on behalf of the Oceanus Team

June 11, 2017

Jet Propulsion Laboratory
California Institute of Technology

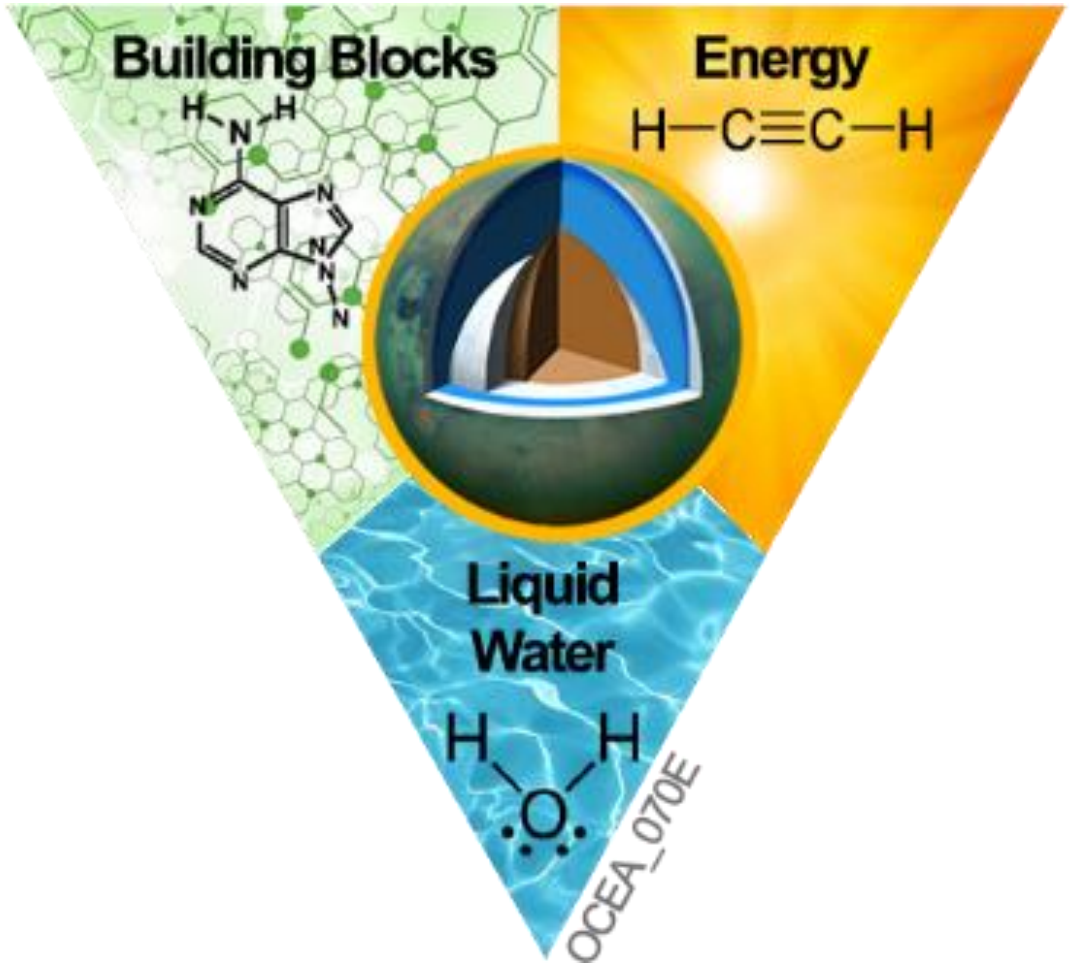
While in Saturn orbit, Cassini has demonstrated that:

- Heavy organic molecules, ions and neutrals, are formed at high altitude (950 – 1400 km)
- Titan's surface is geologically rich with lakes, seas, river, networks, dune fields, mountains, impact craters, plains, labyrinths, putative cryovolcanic features…
- Titan's surface is geologically young
- A global deep salty water ocean is present below the ice crust
- Hydrated silicates are postulated to have been in contact with the ocean
- Possible exchange processes between the silicate core and the surface (^{40}Ar) have happened in a geologically recent past



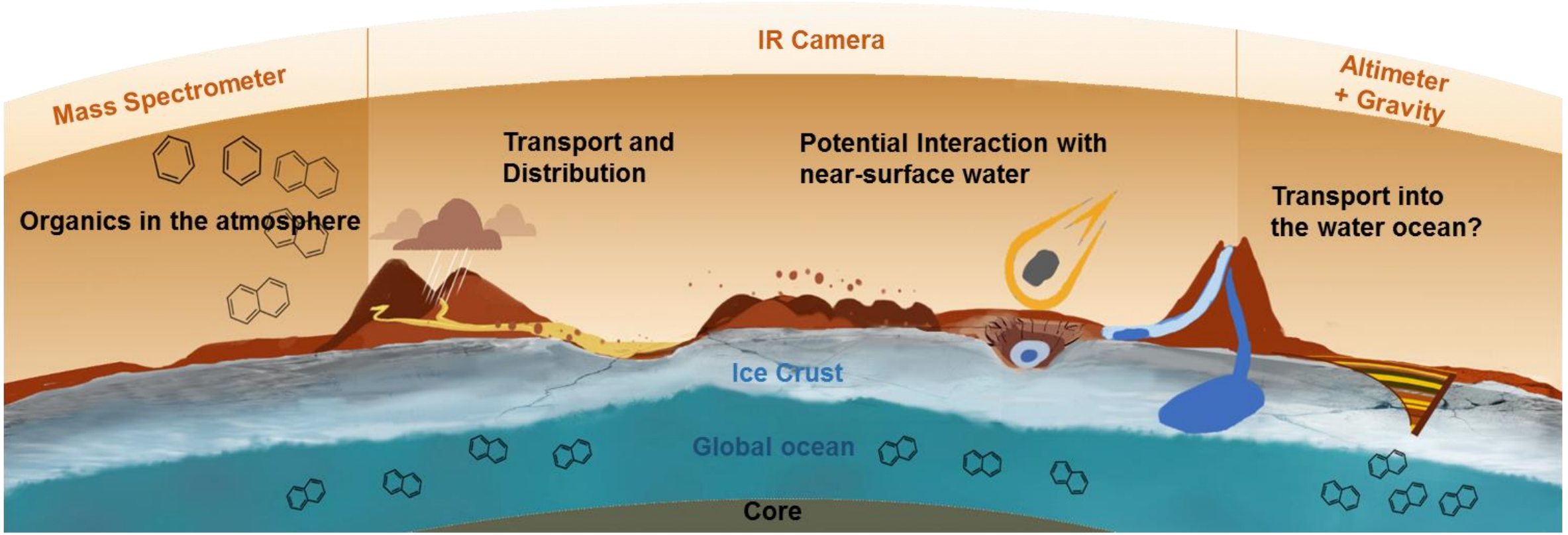
Titan has three key ingredients for habitability

Do they interact to make favorable environments?

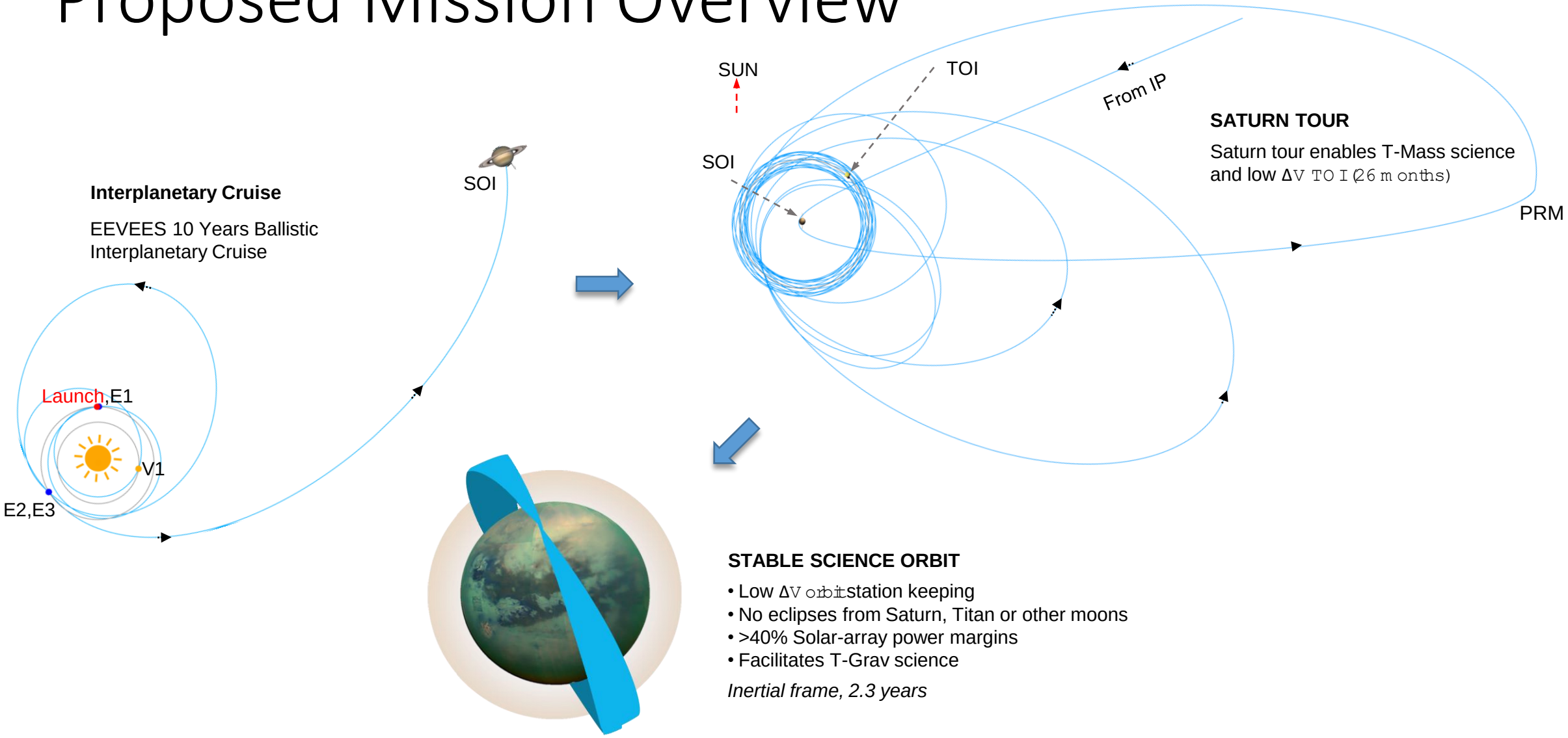


Three instruments & Radio-science

Chemistry + Geology + Geophysics → Astrobiology



Proposed Mission Overview



Interplanetary Cruise

EEVEES 10 Years Ballistic Interplanetary Cruise

SATURN TOUR

Saturn tour enables T-Mass science and low ΔV TOI (26 months)

STABLE SCIENCE ORBIT

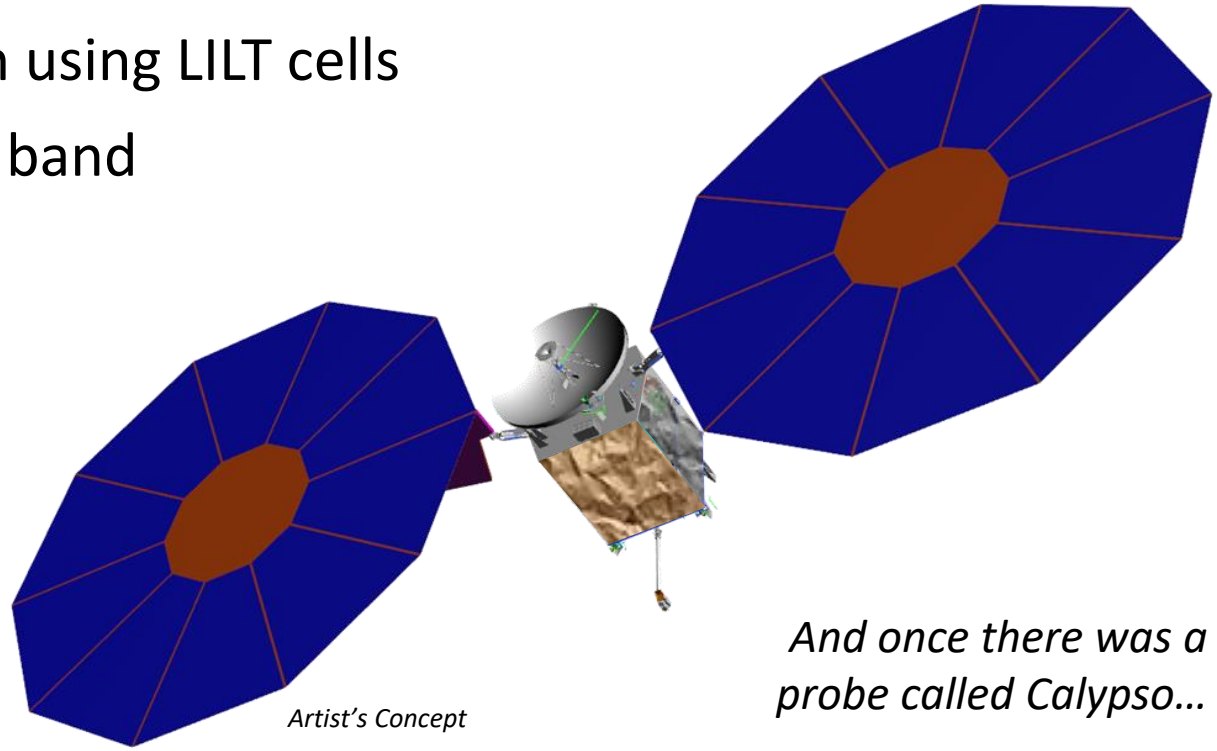
- Low ΔV orbit station keeping
- No eclipses from Saturn, Titan or other moons
- >40% Solar-array power margins
- Facilitates T-Grav science

Inertial frame, 2.3 years

Proposed Flight System Elements

Oceanus' flight system consists of a three-axis controlled, solar powered spacecraft

- Orbit insertion first at Saturn, then at Titan
- Solar arrays supply power at Titan using LILT cells
- High-Gain Antenna with X and Ka band telecommunication system
- Three science instruments
  - Mass Spectrometer
  - IR Camera
  - Radar Altimeter

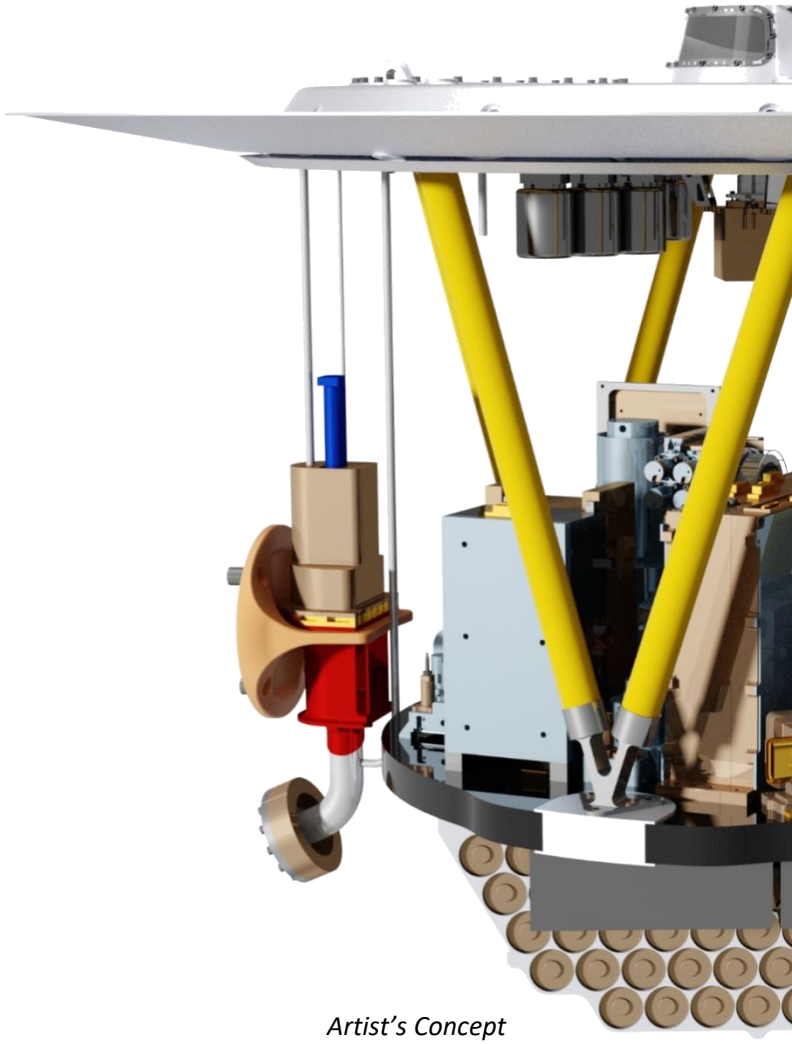


Artist's Concept

And once there was a probe called Calypso…

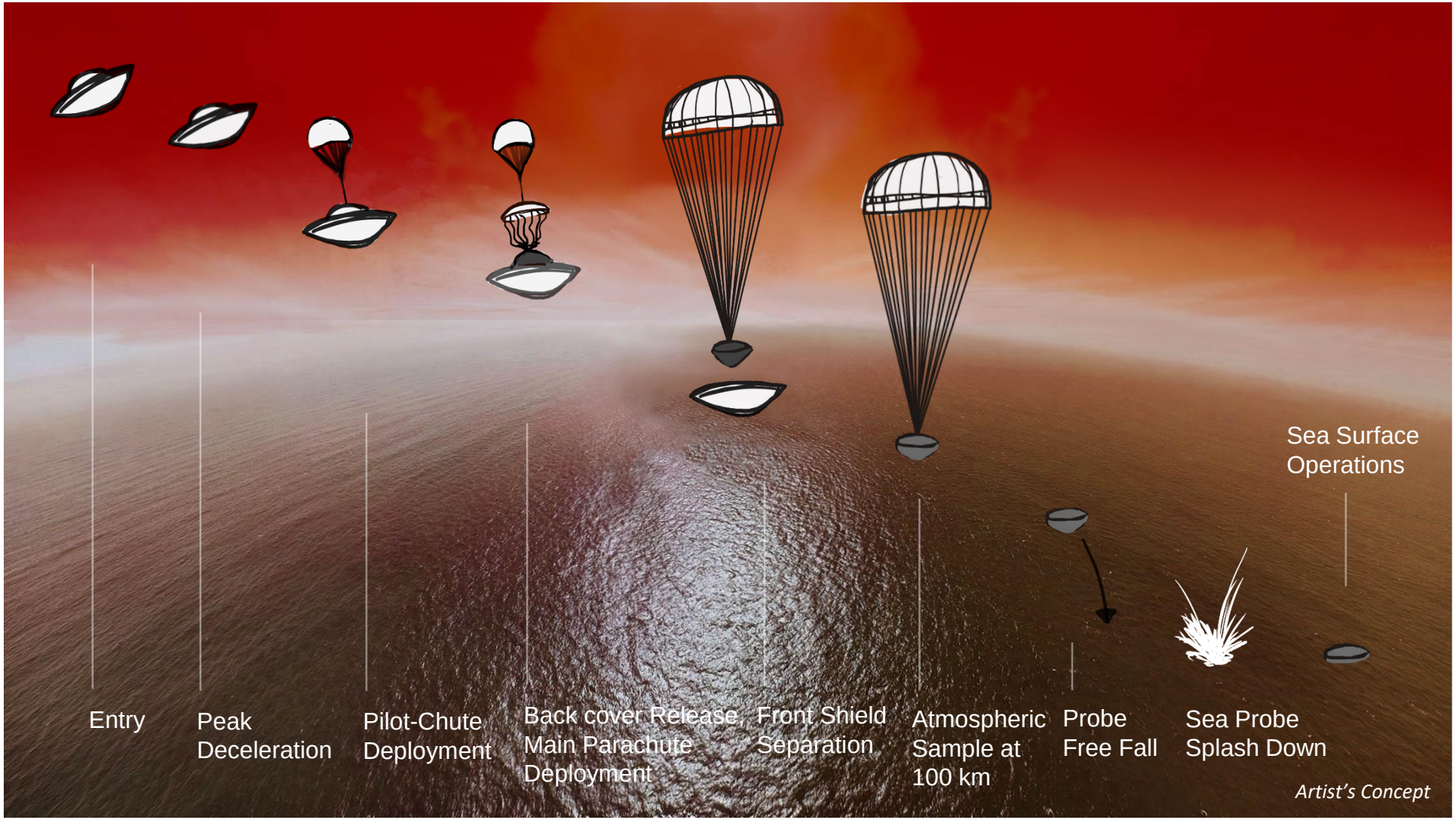
Probe Architecture Drivers

- Low mass/cost
  - Mass impacts orbiter design, impacts cost modeling
  - Ease of assembly and test
- EDL
  - Requirement to take upper atmosphere measurement at ~100 km
  - Need to minimize descent time to maximize time in sea
  - Minimize landing ellipse to safely fit in Kraken Mare
  - Splashdown load should be <20 g for mass spectrometer instrument
- Thermal
  - Need to minimize need for survival heating during 30 day coast period
  - Heat leak to the sea must be minimized (goal of <100 W/m2)
- Surface stability
  - Probe must be buoyant and stable for range of possible sea densities (500-630 g/cm3)
- Integration
  - Accommodate sample inlets for atmosphere and lake
  - Accommodate camera for descent and context imaging

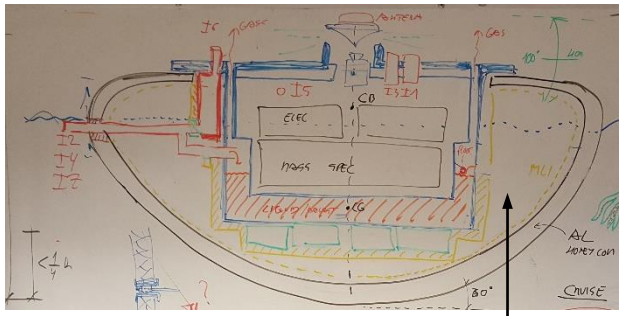


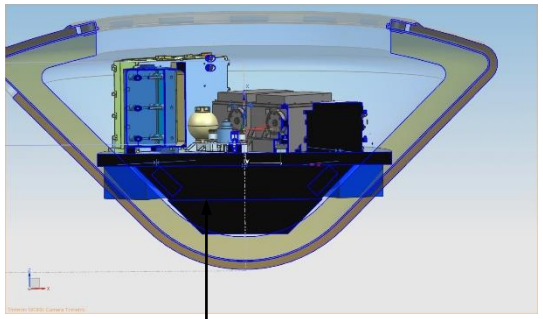
Artist's Concept

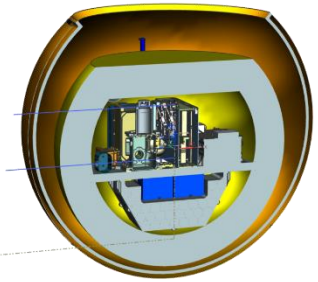
Notional EDL Sequence



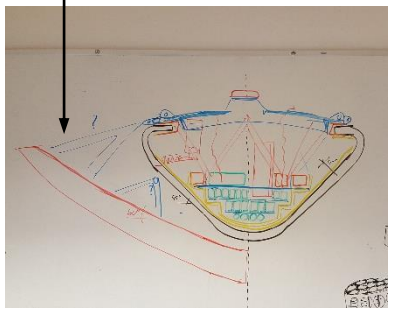
Architecture Evolution

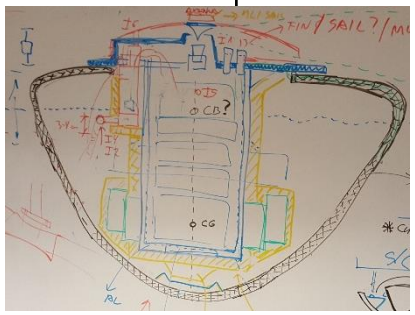


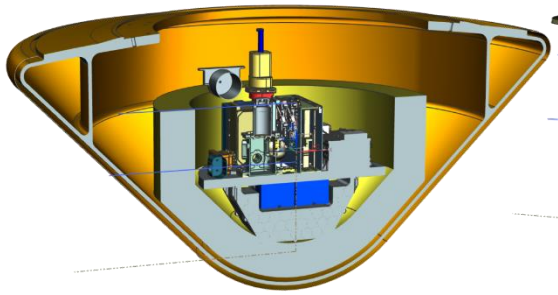


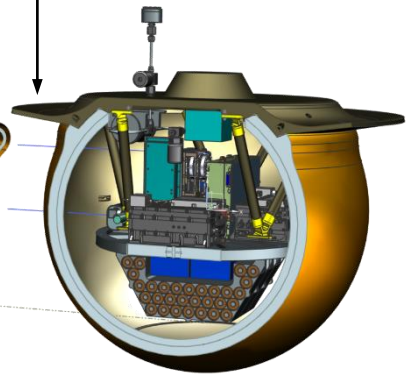


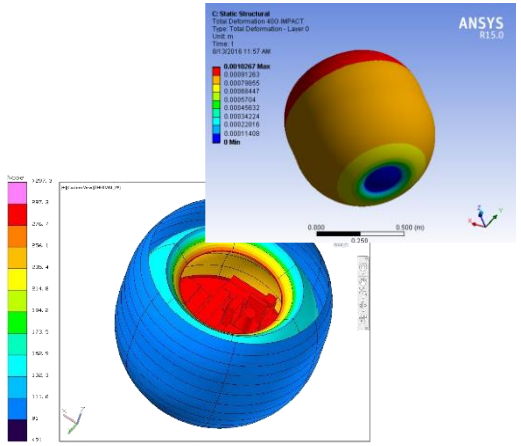
Day 8



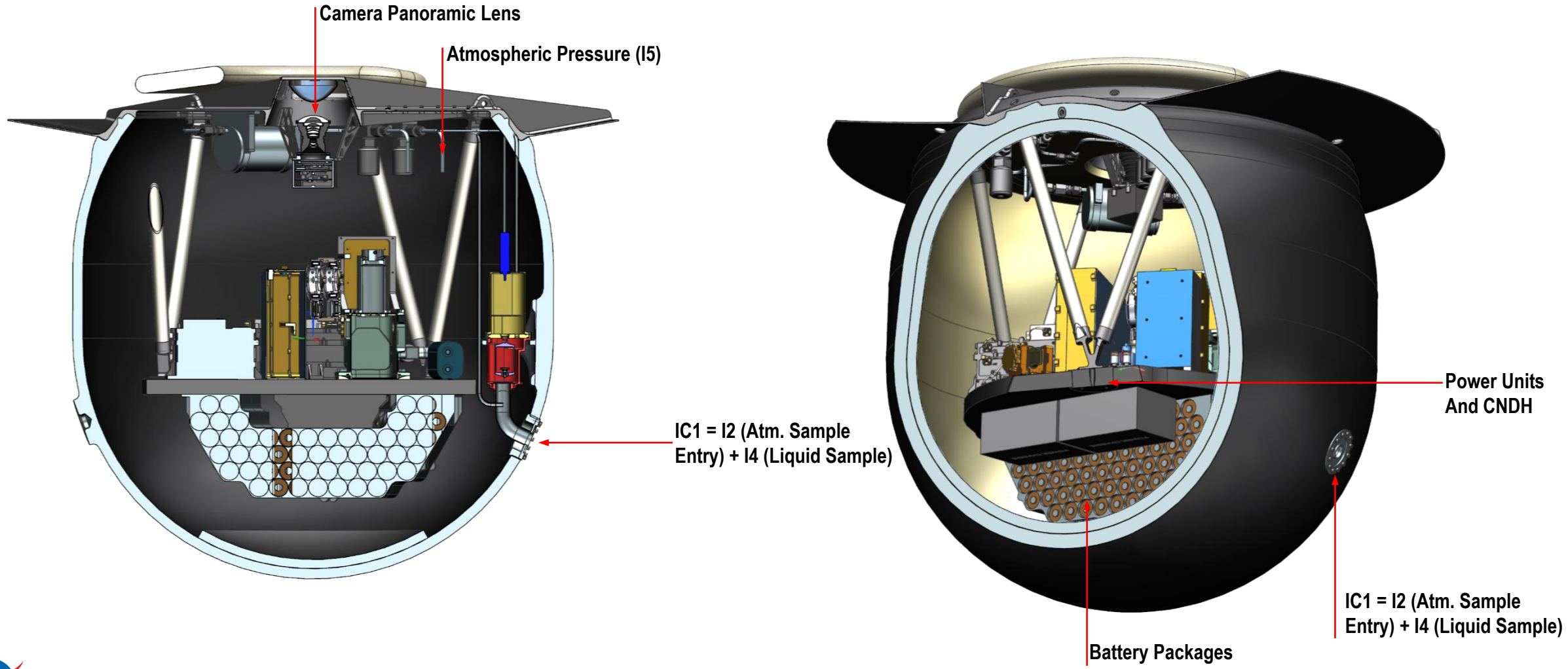




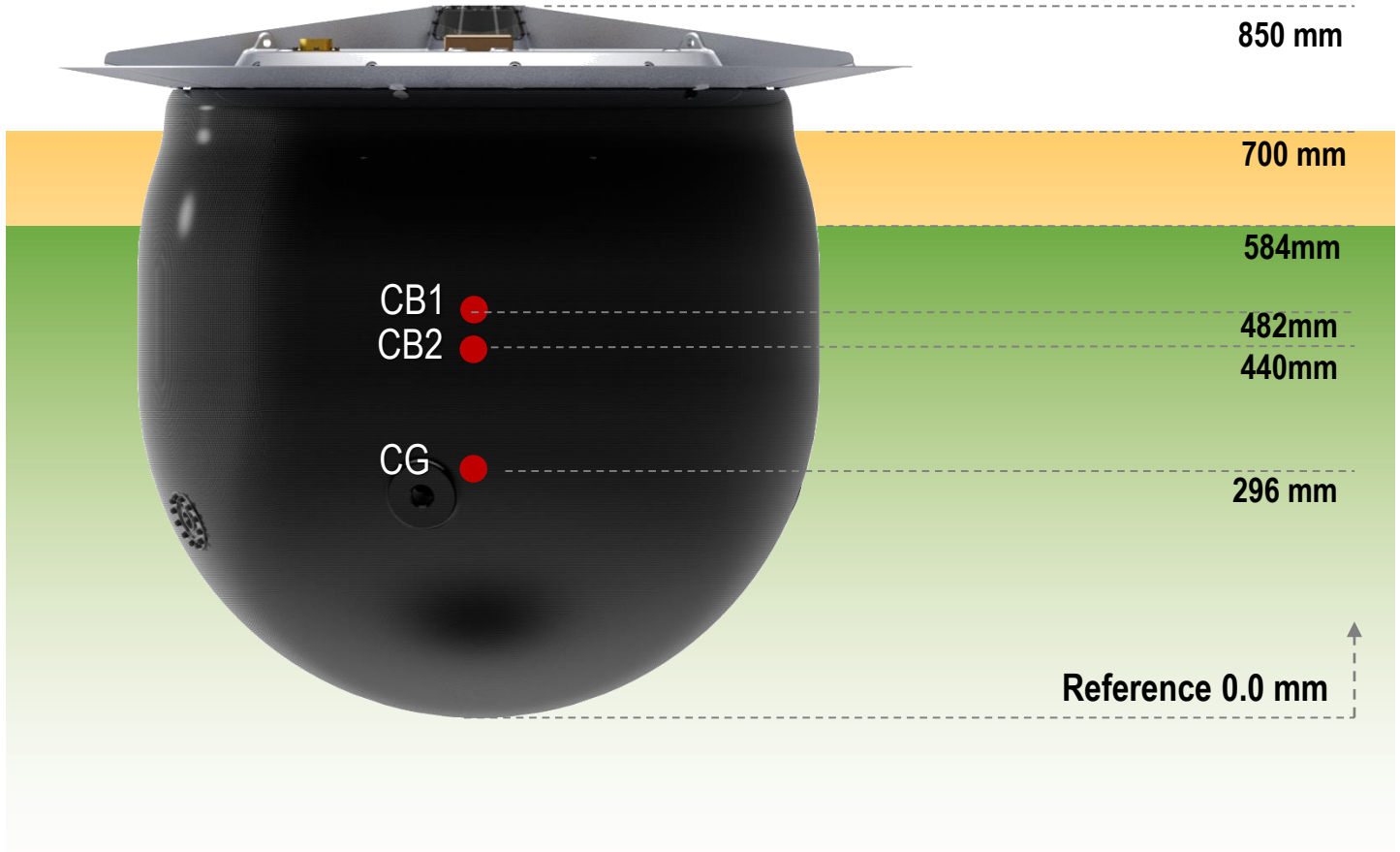




Proposed Internal Configuration



Buoyancy



Float Level, minimum sea density (500 kg/m^3)

Float Level, maximum sea density (630 kg/m^3)

Summary

Science priorities led to development of a highly integrated orbital mission

Oceanus mission concept would perform:

- in situ analysis of Titan's organics
- High-resolution mapping (10× better than Cassini) of at least 50% of Titan's diverse surface
- Global altimetry
- Interior structure with gravity coefficients up to degree 8 (and likely 12)

Team of chemists, geologists and geophysicists