

Titan Sample Return: the TURTLE mission

As a wise mathematician once reminded us, “Life finds a way” – and on their eternal quest toward finding that life, planetary scientists have their sights firmly set on the seas and skies of Saturn’s largest moon, Titan.

THE PROMISE

As the only extraterrestrial body in our solar system known to have bodies of surface liquid, Titan is a fascinating target for planetary scientists. Its methane- based hydrological cycle has features similar to our water cycle on Earth: rain and rivers, clouds and condensation, and most fascinating of all, large methane-ethane lakes whose surface areas rival the largest of the Great Lakes on Earth.

THE PROPOSAL

In response to this scientific opportunity, the TURTLE mission (The Undersea Return of Titan Lake Extractions) will collect solid, liquid, and gaseous specimens from Titan’s north polar region. The samples will be collected above, within, and at the bottom of the Ligeia Mare lake, providing an unparalleled glimpse into Titan’s methane-based hydrological cycle and its potential to support life as we don’t yet know it.

Our mission consists of two main components:

- an orbiter designed for lander support and sample return, and
- a lander designed to splash down onto Ligeia Mare for sample collection, analysis, and delivery into Titan orbit.

THE ORBITER

The Orbiter is a large monolithic spacecraft leveraging heritage from both the successful Cassini mission to Saturn and the design of the NASA/ESA Mars Sample Return mission. During the mission, the Orbiter fills three distinct roles:

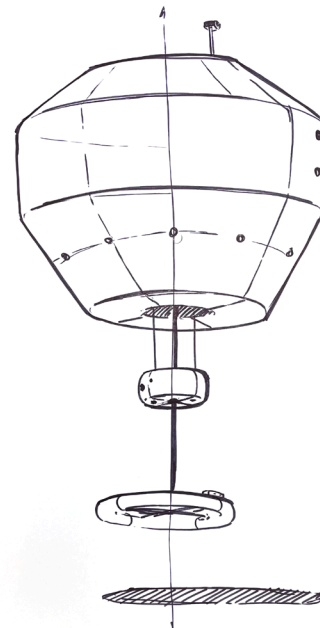
- transporting the Lander from Earth to Titan polar orbit and inserting it on a Titan atmospheric entry trajectory,
- providing communications and imaging support during Lander surface operations, and
- performing a rendezvous with the orbiting samples collected and launched by the Lander and transporting them safely back to Earth.

THE LANDER

The Lander contains a large scientific buoy named BOBII within the entry, descent, and landing (EDL) system needed to get BOBII safely onto the surface of Ligeia Mare. BOBII itself is a highly capable platform modeled after anchored oceanic research buoys

used on Earth. Notably, it features an undersea Profiler which can travel up and down BOBII’s anchor cable from lake bed to surface, collecting both measurements and samples of Ligeia Mare at a variety of depths directly beneath BOBII.

In addition to its critical science objectives, BOBII serves as a seaborne launch platform for the Titan Ascent Vehicle, a liquid-propelled rocket which carries the collected samples into Titan orbit for rendezvous with the Orbiter.

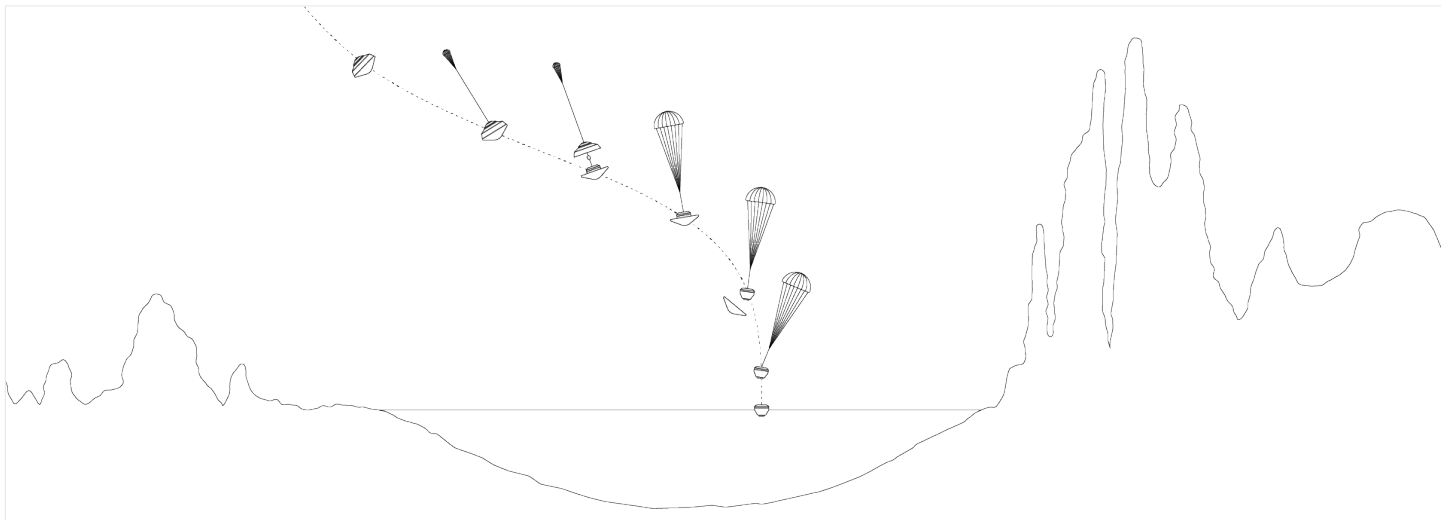


THE MISSION

THE LONG ROAD TO TITAN

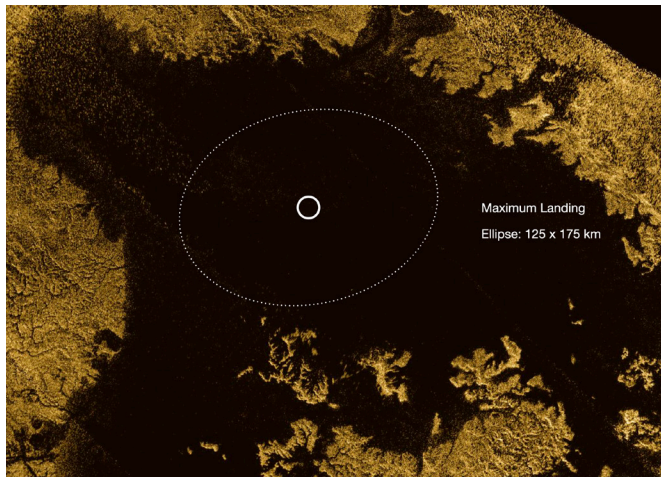
A super-heavy launcher will be used to inject the Orbiter-Lander on their eight-year trajectory to Titan, flying by both Earth and Venus along the way. Upon arrival in the Saturn system, the Orbiter-Lander will perform a series of burns and Titan aerobraking maneuvers to reach a polar Titan orbit. Upon arrival at Titan, the Orbiter will use its on-board instrument suite to characterize the surface of Ligeia Mare and the Titan atmospheric wind profile to finalize the Lander entry trajectory.

TITAN SAMPLE RETURN



TITAN EDL

The EDL system builds on the successful landing of Huygens on Titan and on decades of experience in entry capsule design by using an ablative heat shield to slow the Lander down in the thick Titan atmosphere. Once the Lander reaches Titan's stratosphere, a parachute system is deployed as the Lander separates from its heat shield and backshell for an Apollo-style splashdown landing.



SURFACE OPERATIONS

After instrument checkout, BOBII (the Buoyant Observation and In-situ Investigation) will deploy the Profiler to perform measurements and collect liquid samples at varying lake depths as well as a solid sample at the lake bottom. In parallel, BOBII will be performing its own measurements and collecting samples of the surface liquid and near-surface atmosphere at the fixed location of BOBII. Both sets of samples will be combined in a single carousel which will undergo a non-destructive analysis on-board BOBII before being loaded into the nose cone of the Titan Ascent Vehicle.

RETURNING THE SAMPLES

The Titan Ascent Vehicle will bring the samples into Titan orbit, where the Orbiter will use a combination of radar and visual measurements to rendezvous with and ingest the samples. The Orbiter will then use a combination of chemical and electric propulsion to raise itself out of Titan orbit and perform one final Saturn flyby before setting out on the journey back to Earth with the samples safely tucked away.

