

To Titan beyond HUYGENS: technological stakes and mission concepts

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Abstract

Our view of the Saturnian system has been renewed by the NASA/ESA/ASI CASSINI-HUYGENS mission. CASSINI numerous flyby and HUYGENS in depth exploration has revealed Titan, leaving us with a long list of outstanding questions. A strong willingness for a deeper exploration of Titan raised both in the USA and Europe. Scientists and agencies have initiated work to define a future mission to Titan and the Saturnian System, via the NASA OPAG and ESA Cosmic Vision programmes. This presentation suggests probes concepts, enabling to reach the objectives identified by the scientific community.

Both large mobility vehicle like balloon and smaller vehicles addressing specific science features are identified complementary to the primary mission. Technologies developed in the frame of ESA Exomars Programme is accounted for this overview, in addition to current European development.

1. Introduction

The CASSINI-HUYGENS mission has revealed a complex world, with fluvial systems, Dunes, Clouds, lakes, rain-snow.

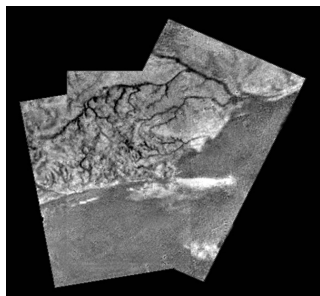


Figure 1: Titan viewed by HUYGENS (ESA/NASA/University of Arizona)

Titan is now viewed as a system, as presented by the TANDEM Cosmic Vision Team.

These discoveries have raised more questions on the behaviour of this world, opening a new field for its exploration.

2. Science objectives constrains the mission concept

The scientific objectives for a mission to Titan includes mainly methane cycle, atmosphere / surface interaction, atmosphere dynamics, liquid surface.

These objectives lead to different mission constraints. Atmosphere exploration induces to cross a large range of altitude to extract the structural features. Vehicle concept is hence similar to HUYGENS, devoted to the descent.

The exploration of Titan Surface, and its interaction with the atmosphere is one of the major goal for a future mission. The overall planet shall be covered, with a large range of longitude and tentatively also of latitude. Large mobility vehicle with Montgolfiere or Hot air balloon are necessary to cover all this range. Studies have been ran since several years for such mission, Titan being a perfect world to fly a Montgolfiere, due to its atmosphere specificities (density and temperature).

3. Mission concepts

Electrical power is the key constraint for a mission to Titan. The solar illumination is almost null on the surface. The mission duration is hence the key driver for the concept and for the development duration of a future mission to Titan.

Flying a Montgolfiere requires Radioisotopic Thermal Generator, for both electrical power generation and heating the air inside the balloon itself, and provides for the buoyancy.

Other mission concepts are proposed, using available technologies or with a shorter development duration. These smaller probes will be devoted to a limited range of scientific objectives: atmosphere structure, surface meteorological station. Multiple probes could be considered, to target multiple objectives.

Our knowledge of Titan following HUYGENS success leads to review our design margins, for probes more optimized than HUYGENS which, as the pioneering mission, had to be conservatively designed.

4. Summary and Conclusions

Several concepts of mission to develop Titan exploration are reviewed, from unique large mission which covers the full range of scientific objectives, to smaller missions, which should target specific features.

Such an overview is proposed as a support for both Scientists and Agencies to define the future mission to Titan, affordable within the reality of this beginning of 21st century.