



## Project Objectives

Nowadays, chemical propulsion is based on solid (launch applications like first stage booster) or liquid technologies (primary stages, upper stage engines). Complementary, hybrid propulsion technology, as defined in ORPHEE, appears as a new generation of advanced space transportation systems. Engines based on this innovative propulsion concept can provide advantages such as high thrust and specific impulse, throttling (thrust modulation), versatility (easy adaptation to various configurations) and safety.

Beyond these technological advantages, it will help to consolidate the long term sustainability and ensure a technology needed by the European propulsion space community to remain competitive in the long term.

Hybrid propulsion principle is based on the injection of a liquid or gaseous oxidizer into the engine combustion chamber where it reacts with a solid fuel to generate hot gases providing the thrust. Enlarging the burning surface is the currently favoured solution to reach the needed performance level. However, it dramatically increases the solid grain volume and the engine weight, limiting the applications.

The regression rate is a key parameter controlling the solid fuel grain design. Its increase is a very attractive solution to reduce the grain volume.

The main objectives of ORPHEE are to increase versatility of space propulsion systems, to ensure a significant increase of hybrid engine performance, to improve the solid fuel technological maturity, to gather European skills on hybrid propulsion and to economize on the European access to space.

In near future, the availability of new hybrid engines will allow the access to new space transportation missions. By consolidating the knowledge on this innovative technology, the European space propulsion community will strengthen its global position.

## Expected results at the end of project (2011)

The scientific and technological objectives are related to provide European space industries a better and new knowledge on hybrid technology. Missions definition and propulsive performance requirements are also defined to induce preliminary designs of demonstrators.

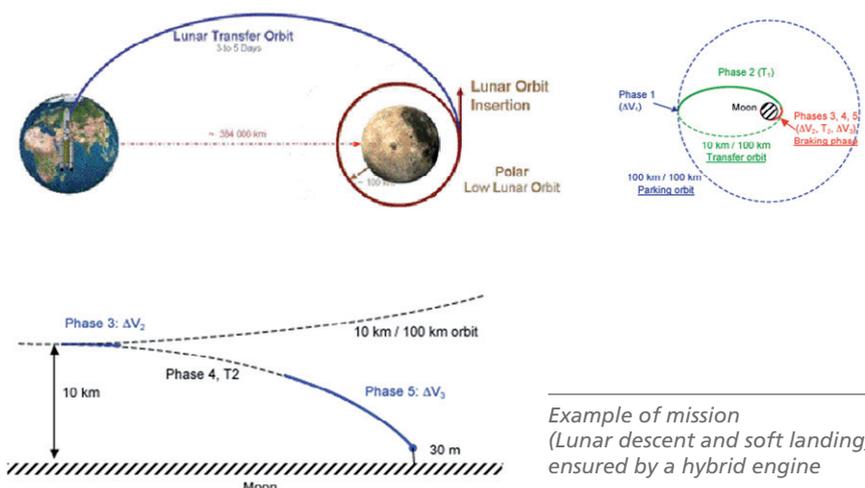


Finally, the main innovative assets will deal with:

- New knowledge on fuel and oxidizer materials,
- Development of
  - characterization methodology by experimental set up improvement and adaptation (small & laboratory scale),
  - models for engine preliminary design,
  - manufacturing device and safety knowledge involved in the grain manufacturing,
- Better understanding of physical phenomena involved in hybrid engine operating,
- Proposition of demonstrator design.

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Example of mission  
 (Lunar descent and soft landing)  
 ensured by a hybrid engine